Supplement to The Australian Zoologist, Vol. 13, Part 4, 1966

THE AUSTRALIAN ZOOLOGIST

Volume 13

★

1963 - 1966

★

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES, SYDNEY

Registered at the G.P.O., Sydney, for transmission by post as a periodical.

THE AUSTRALIAN ZOOLOGIST

Issued by the
ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

Volume XIII — Part 1

September 18, 1963

Price £1

All communications to be addressed to the Hon. Secretary,
Royal Zoological Society of New South Wales,
28 Martin Place, Sydney.

Registered at the G.P.O., Sydney, for transmission by post as a periodical.

THE AUSTRALIAN ZOOLOGIST

Volume XIII Part 1

Notes on the Hawk-Moths and Butterflies of Bandon Grove, N.S.W.

By Miss M. J. Dowling and L. Courtney Haines.

Bandon Grove is situated in the Williams River Valley approximately 30 miles inland from the coast and 70 miles north of Newcastle. The Williams River rises in the Barrington Tops and is joined near the little village of Bandon Grove by the Chichester River, a smaller stream, having its headwater in the foothills of the Barrington Tops. These rivers, in places crystal clear, are shaded by Weeping Willows, Basket Willows, Iron-woods, River Oaks, Lillypillies, and for bright spots of colour, the Red Bottle-Brushes.

The surrounding countryside consists of undulating "parklands" and although a good deal of the land has been cleared and taken over for farming and grazing, heavily wooded hills are still to be found, one not having far to go before finding oneself amidst the wild beauty of tall timber and virgin forest. In the vicinity of Bandon Grove the remaining trees consist of Ironbarks, Grey and Spotted Gums, a few Stringy-barks and Apple Gums, while in marshy areas, and bordering the shallow creeks, Paper-barks, Tea-trees and Black Wattles predominate.

Along the hillsides and in the gullies, wherever Lantana and Wild Orange bushes flourish, many species of day-flying Lepidoptera may be observed; it is, however, in the garden surrounding the homestead, appropriately named "Canningalla," an Aboriginal word meaning "at the foot of the Hills," that the authors have done most of their collecting.

The garden is surrounded by Silky Oaks, English Oaks, Pittosporums, Kurrajongs, Orange Trees and shrubs, among which Duranta, Weigelia, and Buddleia are the greatest attractants as far as the butterflies are concerned. Along the fences trail Wistaria and Honeysuckle vines, and hedges of Plumbago and other sweet smelling plants grow here and there in wild profusion. At the twilight hour when the still air is heavy with the scent of garden sweets, shadowy forms of moths are to be observed darting frenziedly from bloom to bloom. While Hawk-moths carefully investigate the Petunias, Stocks and Honeysuckle blooms, numerous Owl moths dash madly about the tree-tops, in their whirling flight silhouetted against the glowing sky-line. On occasions those large fruit-sucking Noctuas, *Ophideres materna* and *O. salamia* are attracted to the house lights, and frequently their curious caterpillars are found feeding on the large heart-shaped leaves of a vine belonging to the order Minispermaceae, which grows abundantly in a nearby gully.

In these charming surroundings of wooded vales, grassy meadows, and gardens, we have either captured on the wing, or hatched out in our breeding cages many species of Lepidoptera belonging to the various macro-families of moths. At this stage, however, we propose to discuss only the Hawk-Moths and the Butterflies, there being no less than 15 species of the former and 63 of the latter.

ANNOTATED LIST.

Division Heterocera.

Family Sphingidae. Hawk-Moths.

1. *Tetrachroa edwardsi* Oliff. Edwards Hawk-Moth. A specimen of this scarce and most attractive hawk came to light about 10.30 p.m. on the evening of January 30th, 1959. The night was warm with a gentle movement in the air from the north west. While as yet only a single capture has been made at Bandon Grove, at least two specimens have been taken on lamp posts in Dungog by school children, during the summer of 1957.

2. *Chromis erotus* Cramer. Orange-underwing Hawk. Not at all plentiful, and until recently four specimens only had been taken at light. During the past two years, another four were bred out from caterpillars found feeding on Black Muscatel Grape-vine and Virginia Creeper leaves.

3. *Ascosmeryx cinerea* Butler. Olive-shades Hawk. A fairly common species which is readily attracted to light. It occurs from November to February. Larvae have been found feeding on Grapevine leaves, Rosea, and *Cayratia climatidea,* sometimes referred to as *Vitis climatidea,* "Wild Grape."

4. *Psilogramma menephron casuarinae* Walker. Casuarina Hawk-Moth. This big grey hawk is easily netted as it probes for nectar among the flowers of *Bignonia lindleyana.* It is also attracted to some of the sweet smelling lilies. The handsome caterpillars have been found eating the leaves of the Bignonia, Tecoma, Variagate Privet, and Common Privet. In other localities larvae have also been found on Lilac, and on Blue Bush, *Notelea longifolia,* à native shrub. Casuarina Hawks are on the wing from December to February.

5. *Herse convolvuli* L. Convolvulus Hawk-Moth. Specimens have been observed and captured on the wing during October, November, and again in March. Although some have been collected at light, the majority of captures are to be made amidst the garden flowers during the twilight hours. The caterpillars feed upon Sweet Potato and Convolvulus leaves.

6. *Herse godarti* Macleay. Inland Hawk. One record only of this interesting species. The specimen was captured during 1959 by a local school teacher. It was netted as it hovered over the flowers of the Honeysuckle.

7. *Celerio lineata livorniciodes* Lucas. Pink-striped Hawk. Four specimens taken at light during March, 1959. All four made their appearance about 9 o'clock in the evening.

8. *Cephonodes kingii* Macleay. Broad-marked Clear-wing. Two of these fascinating day-flying hawks have been captured, one in the adjoining district of Fosterton on 14th March, 1959, and the other at Bandon Grove on the following day. At both places during these two days, several specimens were observed, darting about in the hot sunshine, their wonderful tail-fans expanded, as they investigated the garden sweets. The Duranta flowers were mainly favoured at Fosterton, while at Bandon Grove the blooms of the native *Ehretia acuminata* were the main attraction. Several larvae found feeding on Gardenia have been bred out.

9. *Cephonodes hylas* L. Lesser-marked Clear-wing. A number of specimens have been bred from caterpillars found feeding on Gardenia.

10. *Macroglossum hirundo errans* Walker. Humming-bird Hawk-moth. This strange moth is also called the Bee-hawk. Its presence is usually made known by a distinct humming sound, produced as it darts and hovers about the flowers during the dusk. A specimen was captured during the evening of February 5th, 1959, and being such an extremely fast flier, it was some time before it was successfully netted.

11. *Hippotion scrofa* Boisduval. Vermillion Under-wing Hawk. A common species from October to December, when numbers of them may be seen flying around the Orange blossoms at dusk; but as the shadows of night deepen, they vanish as quickly and mysteriously as they appeared. Light attracts this species, and they may often be found clinging to a curtain near an open window. The forewings of *H. scrofa* are subject to quite a deal of variation, as far as colour and markings are concerned.

12. *Hippotion celerio* L. Silver-striped Hawk. Another very common, but beautiful, hawk, to be observed on the wing for a greater length of time before retiring for the winter than the previous species. Larvae have been found feeding on Grape vine, Rosea, and "Wild Grape."

13. *Theretra oldenlandiae firmata* Walker. Silver-striped Green-Hawk. Fairly common from December to February. Mostly attracted to Verbena, Phlox, Weigelia, Bignonia and Lupin flowers during dusk. This species is also readily attracted to light. The very striking black and yellow caterpillars feed upon quite a variety of plants, these being Godartia, Clarkia, Fuschia, Wild Grape vine, Bignonia and one of the Arum Lilies.

14. *Theretra nessus* Drury. Golden-striped Hawk. Three specimens of this splendid hawk were taken at light about eight years ago.

15. *Theretra clotho celato* Butler. The Barred Brown. Another very fine hawk, a single example of which was taken at light about the same period as the previous species. Neither *T. nessus* or *T. clotho* have been observed since.

Division Rhopalocera.

Family Papilionidae. Swallowtails.

1. *Eurycus cressida cressida* Fabricius. Big Greasy. This northern species has occurred on three occasions. The first, a male in very good condition, was taken as it settled on the flowers of a Weigelia on 11th October, 1958. The second, a perfect female, was caught after it had settled on Orange blossoms on the morning of 22nd October, 1958. On both occasions the mornings were very hot with a westerly wind blowing. The third specimen, a male, was observed flying near the river on the morning of 13th October, 1961.

2. *Papilio sarpedon choredon* Felder. Blue Triangle. Rather scarce until the summer of 1959, when a number were observed, but as most of them were in a worn condition, no attempt was made to net them. A number of eggs and caterpillars have been found on the young leaves of Camphor Laurel trees. This butterfly appears to be quite common in Dungog, a town 9 miles to the south, though until recent years very few specimens have been seen at Bandon Grove.

3. *Papilio macleayanus* Leach. Green Swallowtail. Only ten specimens have been taken, and it is therefore by no means a common butterfly. It was somewhat more numerous during the season of 1959, when several were observed in the garden. In this district, however, *P. macleayanus* seems to prefer gullies, where it delights in hovering over the blooms of the Rosewood trees and Blackthorn bushes. This true swallowtail is also attracted to thickets of Lantana growing along the banks of the rivers.

4. *Papilio aegeus aegeus* Donovan. Orchard Swallowtail. Fairly common, though in some years it is more numerous than in others. The caterpillars have been found feeding on Citrus trees and on a native shrub, the leaves of which gave a very strong smell of citron when crushed.

5. *Papilio anactus* Macleay. Dingy Swallowtail. This butterfly, with its gliding flight, is always plentiful each year. It favours the leaves of the Common Lemon tree on which to deposit its eggs.

6. *Papilio demoleus sthenelus* Macleay. Chequered Swallowtail. Until the season of 1959, only five specimens had been taken. Since then, however, the species has become more common, and larvae found feeding on *Psoralia*, have been bred out.

Family Pieridae. Jezabels, Whites and Yellows.

7. *Delia nigrina* Fabricius. Common Painted White. This attractive butterfly is usually fairly common during late autumn, and may be seen frequenting the flowers of the Loquat trees. At Fosterton, some miles to the east of Brandon Grove, the species occurs in greater numbers. This is probably due to the greater quantity of Mistletoe, the food-plant of the species, that occurs in that district.

8. *Delias aganippe* Donovan. Wood White. Mostly observed when the Silky Oaks are in bloom, and then only on rare occasions, six specimens in all having been captured over the years. Although there are a number of Wild Cherry trees growing in the district, the caterpillars of this butterfly have, as yet, not been found.

9. *Delias harpalyce* Donovan. Imperial White. Very scarce. About twelve years ago a freshly emerged female was watched, and after she had dried her wings in the rays of the morning sun, was captured. Not a single specimen has been recorded since.

10. *Delias argenthona argenthona* Fabricius. Northern Painted White. A female in fairly good condition was taken as it rested on a Guava tree during the summer of 1949. (cf. "Proceedings of the Royal Zoological Society of New South Wales," 1957-58, page 27.) A second specimen, a female in a rather battered, though recognizable condition, was caught on the 22nd February, 1962, as it flew slowly across the countryside in a westerly direction. On the 3rd March, 1962, a third specimen, a male in perfect condition, was caught after it had visited the flowers in the garden.

11. *Anaphaeis java teutonia* Fabricius. Caper White. Together with the Milk-weed Butterfly, Capers are one of the commonest of the larger butterflies. During the summer months they are to be seen in hundreds, frequenting particular gullies, where they breed on the Wild Orange bushes. If one walks past these bushes clouds of the butterflies rise into the air, only to settle once again when all is quiet.

12. *Catopsilia pyranthe pythias* Waterhouse and Lyell. Common Migrant. Each year, usually about February, this migrating species makes its appearance. An interesting form, known as *C. p. lacteola,* occurs during April but these never frequent the district for any length of time.

13. *Catopsilia pomona pomona* form *crocale* Fabricius. Lemon Migrant. Although Lemon Migrants have been seen on various occasions over the years, up until 1962 no specimens had been captured, and so positive identification was not possible. On 10th January, 1962, however, a single specimen, a female in perfect condition, was captured and it was found to possess the black antennae which are characteristic of the form *crocale.*

14. *Appias paulina ega* Boisduval. Common Albatross. Until 1959, this migratory species had not been recorded. During January and February of that year, nine specimens were captured and in January and February of 1962, this species was again quite prevalent.

15. *Elodina parthia* Hewitson. Chalk White. A dainty species, rarely seen in the garden. It is quite common, however, in nearby gullies where its food-plant, the Wild Orange, grows.

16. *Elodina egnatia angulipennis* Lucas. Pearl White. Another species which deposits its eggs on the tender young shoots of the Wild Orange. Both the Chalk White and the more fragile Pearl White like to frolic about the Rosewood trees and they frequently rest high up, and out of reach of the net, on the dark green leaves.

17. *Huphina perimale scyllara* Macleay. Australian Gull. On 3rd September, 1959, a single female was captured at Bandon Grove. A number of specimens were seen in this same locality on the 3rd and 4th March, 1962, and three specimens were captured on the 3rd March, 1962, in the adjoining district of Fosterton.

18. *Terias smilax* Donovan. Small Yellow. A fairly common butterfly, especially along the river banks, where they make an attractive sight as they hover over the long, green grass. The Small Yellow occurs each year during March and April, although an occasional specimen is sometimes seen as late as May. Once this butterfly begins to appear, it is quite common.

19. *Terias hecabe sulphurata* Butler. Common Yellow. A much more robust species than *T. smilax,* and also more common. It may be found flitting joyfully over the long meadow grass in secluded places along the river banks.

20. *Terias libythea zoraide* Felder. No-brand Yellow. This species was first recorded in this district in 1959, and between the 7th and 21st of February of that year six specimens, three of each sex, were captured. Two more specimens were caught during November and December 1959, and then no more were recorded till 1962. During February and March of that year this species was extremely common.

21. *Pieris rapae* Donovan. Small White. Known locally as the "Cabbage Moth," this introduced species has strongly established itself.

Family Danaidae. Milkweed Butterflies.

22. *Danaus plexippus* L. The Wanderer or Monarch. Of all the butterflies, the Wanderer is the most plentiful. The reason for this is probably due to the large quantities of Wild Cotton *(Asclepias curassavica),* food-plant of the species, which is to be found growing in the gullies and on the ridges. On occasions hundreds of these big butterflies have been observed clinging to the leaves on Iron-bark trees, in the vicinity of which grew a large patch of Wild Cotton. When disturbed they flew around for a while, only to settle again on the leaves, remaining there until the next disturbance, when the same performance would be repeated. For several days prior to dispersing, they were found frequenting the same group of Iron-barks. Wanderers have been recorded on the wing during all months of the year.

23. *Danaus chrysippus petilia* Stoll. Lesser Wanderer. Another very common species, especially in March, April and May. It is difficult to breed them out from caterpillars collected during these months, as they are very heavily parasitized. Larvae gathered before March are usually not parasitized. Lesser Wanderers are greatly attracted to the bright Zinnia flowers, and also to the vine *Parsonia straminea,* a native climber, widespread in coastal districts.

24. *Danaus melissa hamata* Macleay. Blue Wanderer. Only occasionally observed. The several specimens collected have all been tattered and worn. These stragglers from more northern localities are mainly seen during February and March.

25. *Euploea corinna corinna* Fabricius. Common Crow. Extremely scarce at Bandon Grove, and more likely to be seen in Dungog. One specimen was captured many years ago, and two others were taken on 4th November, 1959 and 4th April, 1960.

Family Nymphalidae. Brush-footed Butterflies.

26. *Hypolimnas bolina nerina* Fabricius. Royal Emperor. By far the finest butterfly occurring in the district. This species is attracted to bright flowers, especially zinnias, and may then be caught with a quick side sweep of the net. Royal Emperors possess the habit of returning often to a favoured leaf or twig, where they will settle head downwards, and expand their wings to the rays of the sun. It has been noticed that the females frequently settle on the ground. Although little variation is to be found in the males, striking aberrations occur not infrequently in the female sex. There appears to be several distinct forms, with modifications of each now and then making an appearance. The food-plant is Paddy's Lucerne; but as yet the caterpillars have not been found at Bandon Grove. On one occasion, a female was watched as she deposited an egg; it was, however, later destroyed by ants. It will be interesting to see whether this aristocratic butterfly has the same depraved habits as those possessed by its cousin, the Purple Emperor, *Apatura iris* L. a denizen of the English woods. This most noble species is lured from its lofty flight about the tree-tops, to within range of the net, by placing in the vicinity a dead cat, or hare, in the last stages of putrification. If this bait can be laid in a wayside puddle, so much the better.

27. *Pyrameis itea* Fabricius. Australian Admiral. The Admirals occur quite freely each year, there being plenty of Stinging Nettles to choose from on which to lay their eggs. It has been observed quenching its thirst on ripe grapes which had been pecked by the Silver-eyes *(Zosterops lateralis).* As this butterfly is a hibernating species, it is often observed on the wing during sunny days in winter.

28. *Pyrameis cardui kershawi* McCoy. Australian Painted Lady. An extremely difficult butterfly to capture. It is very plentiful during the summer months, and delights in visiting the flowers of the White Stattice. Caterpillars have been found feeding on a thistle, known locally as the Star Thistle, and also on the little Golden Everlasting.

29. *Precis villida calybe* Fabricius. Meadow Argus. A common species, both in the garden and in the surrounding fields. It possesses a peculiar flat-winged type of flight, and is most difficult to capture; but during the late afternoon when

the air is cooler, Meadow Argus butterflies become sluggish, and can then be quite easily collected as they flap heavily from one patch of grass to another. The larvae feed on a variety of plants, namely Blue Weed, Wild Verbena, Australian Centaury, Lambs Tongue, Antirhinum and Plantains. Blue Weed *(Verbena bonariensis)* and Centaury are the two plants greatly favoured.

30. *Eriboea pyrrhus sempronius* Fabricius. Tailed Emperor. A few of these strong flying "giants" are recorded each summer. Unfortunately, it is difficult to capture specimens with the four tails intact. They are very often attracted to over-ripened fruit, especially Persimmons, on which they will alight to suck the fermented juices. Tailed Emperors are also attracted to a white sheet left hanging from a line. The striking horned caterpillars have been located feeding on two Wattles, *Acacia decurrens* and *Acacia maidensi* and on Kurrajong trees.

31. *Acraea andromacha* Fabricius. Lesser Glasswing. Until recently this species was rarely observed in this district. Since 1958, however, numbers have been captured as they flew in an unobtrusive manner about the pumpkin and lantana flowers. Specimens are easily netted as they glide in gentle flight along sheltered lanes.

Family Satyridae. Browns and Ringlets.

32. *Heteronympha merope merope* Fabricius. Common Brown. Fairly common from November to April. Localities at which they had occurred plentifully during past years, were practically abandoned in the 1958-59 season.

33. *Heteronympha mirifica* Butler. Glade Brown. Very scarce; only three females have been captured. The males, which are on the wing much earlier in the year than the females, have never been observed at Bandon Grove.

34. *Hypocysta metirius* Butler. Common Ringlet. A common butterfly during February and March.

35. *Ypthima arctous* Fabricius. Australian Gate-keeper. Frequents grassy areas and is very abundant.

36. *Xenica acantha acantha* Donovan. Ringed Xenica. Rather scarce, a few only observed each year. They appear to favour the hillsides in this district.

Family Lycaenidae. Blues, Coppers and Hairstreaks.

37. *Candalides absimilis* Felder. Pencilled Blue. From September to December this swift flying butterfly is often observed visiting the sweet scented blooms of the Pittosporum tree. The females are at once distinguished from the males by a white patch on their fore-wings.

38. *Hypochrysops ignita ignita* Leach. Fiery Jewel. Two of these beautiful little butterflies have been recorded, one of which was captured. Both were paying attention to the flowers of the Black Thorn *(Bursaria spinosa).*

39. *Nacaduba lineata* Murray. Hairy Lineblue. Prior to the season of 1959, this species had not been observed. Specimens have since been taken from February to early May, and eggs and larvae have been found during February and March on the buds of *Ehretia acuminata,* a native Peach found growing on the edges of brush forests. The eggs are deposited on the tight buds of this plant, and when these buds burst, the larvae hatch out and feed upon the cramy-white flowers. By the time the flowering period is over the caterpillars are fully fed and ready to pupate. It is extremely difficult to pick out the larvae, as their colour matches exactly the flowers to which they cling. Although most of our captures were made in the vicinity of the food-plant, the Wild Crepe Myrtle also appears to be attractive to this species of butterfly.

40. *Nacaduba biocellata* Felder. Double-spotted Lineblue. Three specimens have been taken on Black Thorn flowers and others have been taken on Wattle flowers.

41. *Nacaduba ancrya florinda* Butler. Speckled Lineblue. October appears to be the month when males of this species are first on the wing, the females not occurring until April and then only for a brief stay. Males have been seen as late as May. Most specimens were netted as they frequent the flowers of a climbing vine *(Parsonia straminia).*

42. *Nacaduba felderi* Murray. Felder's Lineblue. Once again the males of this species appear on the wing long before the females, the former being noticed in February and the latter in April. Most captures are made when the butterflies alight on the Parsonia Vine.

43. *Ogyris amaryllis amaryllis* Hewitson. Amaryllis Azure. A single tattered example of this butterfly was captured at Fosterton, during the 1954 season. On the 15th February, 1962, following a period of strong southerly winds, a second specimen, a male in a battered condition, was found resting on the ground.

44. *Ogyris abrota* Westwood. Dark-purple Azure. This is a very local species and is only found where its food-plant, Mistletoe, occurs. Odd specimens have been observed in very restricted areas where Mistletoe growing on Gum-trees occurs, and a single example was once seen flying around a River Oak tree on which Mistletoe had become established. One female has been captured, and a male has been bred from a pupa found under loose bark of a Gum-tree on which Mistletoe was growing.

45. *Ialmenus ictinus* Hewitson. Ictinus Hairstreak. These electric coloured Hairstreaks are plentiful from October to March. The butterflies deposit their eggs on the Black Wattle *(Acacia decurrens)* and on two other species of *Acacia*. The caterpillars are always attended by Red Meat Ants, and although there are many eggs and larvae, there is never a corresponding number of pupae. It is interesting to note that the butterflies have never been found any great distance from the trees on which they breed.

46. *Neolucia serpentata* Herrich-Schaeffer. Chequered Blue. Only three specimens have been taken, the first in September, 1958, the second in January, 1959, and the third in January, 1962. All of these specimens were in fairly fresh condition.

47. *Syntarucus pseudocassius* Murray. Plumbago Blue. A common species that is only found where its food-plant, Plumbago, occurs.

48. *Lampides boeticus damoetes* Fabricius. Long-tailed Blue. Occasionally observed in the garden. The eggs and larvae have been found on Lupins.

49. *Zizeeria labradus labradus* Godart. Common Grass-blue. During the summer months scores of these little butterflies occur. When the Lucerne is in flower, they swarm in hundred around the blooms in company with the bees. This is by far the commonest small species of butterfly in this district.

50. *Zizeeria lysimon karsandra* Moore. Dark Grass-blue. One female was captured on 4th May, 1959. This is the second most southern record for this butterfly, which is usually regarded as a northern species. (cf. "Proceedings of the Royal Zoological Society of New South Wales," 1958-59, page 110.)

51. *Paralucia pyrodiscus* Rosenstock. Dull Copper. Although Black Thorn, the food-plant of *P. pyrodiscus* is fairly common, there has so far been only one capture of this butterfly. It was taken while resting on the ground, which is unusual, and was in fairly good condition.

Family Hesperiidae. Skippers.

52. *Phoenicops beata* Hewitson. Common Red-eye. A specimen was captured at dusk several years ago while it rested on a verandah rafter.

53. *Netrocoryne repanda repanda* Felder. Eastern Flat. Two specimens were captured during 1957-58; both were taken at about mid-day, and on the same Geranium plant. Several specimens have been taken since then in near-by gullies where they were flying around the bushes.

54. *Traperzites symmomus symmomus* Hubner. Symmomus Skipper. A large and beautiful species, which is occasionally taken on Lantana flowers.

55. *Traperzites petalia* Hewitson. Common White-spot Skipper. This interesting skipper has been taken in the adjoining district of Fosterton. It is attracted to the flowers of the Black Thistle, commonly known as Scotch Thistle.

56. *Toxidia parvula* Plotz. Parvula Skipper. Found frequenting the sheltered gullies. The flowers to which they are most attracted are those of *Parsonia straminia* and *Ehretia acuminata.*

57. *Toxidia doubledayi* Felder. Doubleday's Skipper. This fairly common skipper is usually attracted to the sweet-scented Black Thorn flowers.

58. *Toxidia leucostigma leucostigma* Meyrick and Lower. White-brand Skipper. This species is found inhabiting quiet gullies.

59. *Toxidia peroni* Latreille. Dingy Garden Skipper. Often to be observed in the gullies, and in the garden, where it will settle on almost any plant.

60. *Taractrocera papyria papyria* Boisduval. White-marked Grass Skipper. Three specimens of this skipper were captured during the summer months of 1959 and 1960.

61. *Padraona flavovittata flavovittata* Latreille. Yellow-banded grass Skipper. Mostly found in grassy fields. Though similar in appearance to the next species, it may be separated at once by a glance at the underside of the hindwings which are greenish, those of *P. hespera* being brownish-orange, never green. The food-plant is Couch grass.

62. *Padraona hespera hespera* Waterhouse. Common Grass Skipper. A very common skipper inhabiting similar localities to the previous species. The larvae feed on Grass.

63. *Astycus kreffti ancilla* Herrich-Schaeffer. Greenish Skipper. This species sometimes frequents the flowers of the Lantana, White Stattice and Buddleia. The larvae feed upon Blady Grass *(Imperata arundinacea).*

LOCATION OF SPECIMENS.

The specimens on which the above notes are based are in the authors' collections.

ACKNOWLEDGMENT.

Sincere thanks are due to D. K. McAlpine, M.Sc., Assistant Curator of Insects at the Australian Museum, for allowing us to compare, for the purpose of identification, our Hawk Moth captures with those in the Museum's collection.

Australian Runcinacea (Mollusca: Gastropoda)

By Robert Burn

(3 Nantes Street, Newtown, Geelong, Victoria.)

The coastlines of Australia are particularly rich in opisthobranchiate gastropod molluscs, those of Victoria and New South Wales being the best known. Hardly a collecting trip passes, however, without the discovery of one or more new species, or new records, for some particular zoogeographical area. The present two new species are such discoveries made recently by the writer and friends.

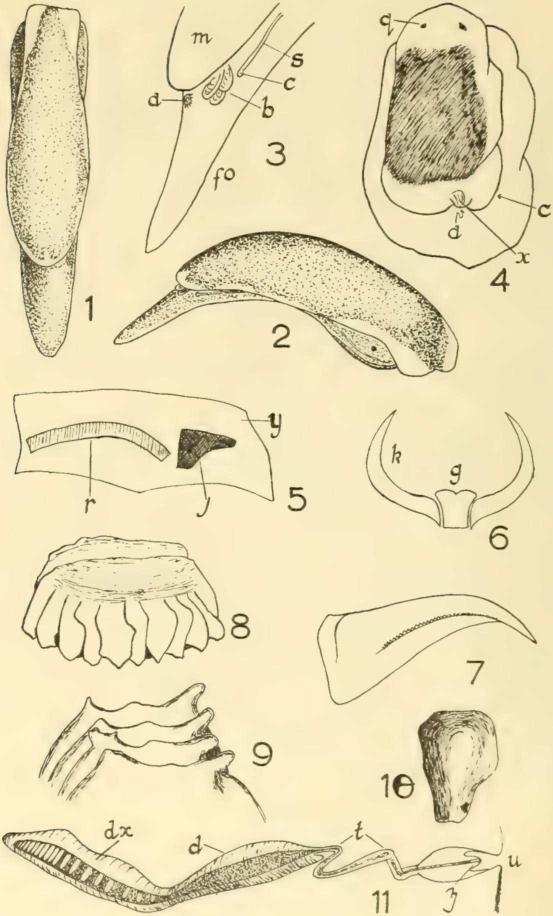
This work has been carried out as part of a comprehensive study of the Opisthobranchia of Australia. The writer wishes to thank in particular the Trustees of the Science and Industry Endowment Fund, C.S.I.R.O., Melbourne, for a grant-in-aid of this overall study. Thanks also go to Miss Joyce Shaw, Librarian, National Museum of Victoria, Melbourne, for unfailing help with references, and to Mr. Charles Gabriel, Melbourne, for similar help. The material upon which this paper is based has been presented to the National Museum of Victoria, Melbourne (referred to as N.M.V. in text).

Runcina australis spec. nov. and *Ilbia ilbi* gen. et spec. nov. are the first records of the Cephalaspidean suborder Runcinacea (= Peltacea; Odhner 1939, p. 6) for the whole of Australia. From New Zealand, Odhner described *Runcinella zelandica* as a new genus and species (1924, pp. 46-51, pl. 1, fig. 30-32, text-figs. 6-9). There are two Japanese species at present described and another has been found once at Mauritius. Beyond these few records, the range of the Runincinacea is on both coasts of the North Atlantic and in the Mediterranean, where five species in all have been found.

From this list of species, it is at once obvious that the Runcinacea form a very small suborder. Comparable with this is the fact that the largest species is only 8 mm. long *(Runcinida elioti)* and the majority are less than 4 mm. long. Unlike the remaining suborders of the Cephalaspidea, the Runcinacea do not have the dorsum transversely divided into two shields and the foot is without lateral extensions or parapodia. Furthermore, the anus is terminal in its position under the posterior mantle and always a little to the right of the median line. The branchia is small and around or to the right of the anus, or absent. A shell is present in *Ildica* and *Runcina* but is absent in *Runcinella, Runcinida* and *Ilbia;* when present it is haliotiform, very small and terminal in position. There are no cephalic tentacles; oral tentacles are present only in *Ildica.* Jaws are present; the radula has a broad rhachidian and one or two lateral teeth. Gastral (triturating) plates are present in the gizzard. The female genital organs have a bursa copulatrix, the male organs an elongate prostate gland. Opaline glands are present in various forms in three genera *(Runcina, Runcinella, Ilbia).*

Odhner (1939, pp. 6-7) suggested the division of the cephalaspidean Opisthobranchia into four suborders, each of which is very clearly defined. The Runcinacea were separated off by their lack of parapodia and by the presence or absence of a very rudimentary shell. Their greatest difference, as mentioned above, is the undivided dorsum of the body, a characteristic which stands them far and above the three more primitive suborders. However the genital organs, in particular the external seminal groove, are typically cephalaspidean and prevent the suborder from being too far removed from its position among the Cephalaspidea. According to Odhner's system the two species described below are classified as follows:

Class	GASTROPODA
Subclass	Opisthobranchia
Order	CEPALASPIDEA
Suborder	Runcinacea
Family	Runcinidae
Subfamily	Runcininae
	Runcina australis spec. nov.
Subfamily	Ilbinae subfam. nov.
	Ilbia ilbi gen. et spec. nov.


1
2
m
s
c
d
b
3
fo
q
c
d
x
4
y
r
j
5
k
g
6
8
7
9
10
dx
d
t
u
11
3

DESCRIPTION OF GENERA AND SPECIES

Runcina Forbes 1851

To this genus belong those Runcinacea with an internal shell, a reduced branchia consisting of a few (3-5) pinnulae just to the right of the anus, and a radula with a multidentate bicuspid rhachidian and one denticulate philinid lateral tooth each side (one species has a degenerate radula in which neither rows nor teeth can be counted, i.e. *R. setoensis* Baba, 1954, p. 373, fig. 1, F, G, H). An elongate prostate gland and a terminal seminal vesicle are present on the male copulatory organ. The colour of the known species is either black or dark green with a lighter marginal band around the dorsum and foot.

Type by monotypy: *R. coronata* (Quatrefages 1844) = *R. hancocki* Forbes 1851. *R. coronata* was originally described as the type (by monotypy) of *Pelta* Quatrefages (1844, p. 151), which was preoccupied by *Pelta* Beck (1837, Index Moll., p. 100).

Runcina australis spec. nov.

Figures 1-11

The living animal is elongate oval in shape, widest at mid-length and rather highly arched across the dorsum. The larger specimen measured 3.5 mm. long and 1 mm. broad. The foot is as wide as the dorsum, the anterior edge is thickened and minutely notched in the median line; the tail is a quarter of the total length, the tail tip is narrowly rounded. The dorsum is smooth, broadly rounded behind, narrower in front and shallowly concave in the truncate anterior margin. The overhang or mantle of the dorsum is very narrow but is continuous all round the body except in front where the dorsum curves down and back into the head and mouth. Oral tentacles are absent. The eyes are lateral (Fig. 2) and do not show dorsally as in *R. coronata* (Pilsbry, 1896, pl. 68, fig. 35, 37, 41) and *R. setoensis* (Baba 1954, p. 374, fig. 1, A).

The anus (Fig. 3, *a*) is just to the right of the median line in its terminal position between the mantle and the tail. The three minute pinnulae (3*b*) comprising the branchia are clustered together to the right of the anus; they do not encroach upon the anus as in *R. coronata* (Alder and Hancock, 1846, pl. 4, fig. 4) nor are they as large. Below and in front of the branchia is the common genital aperture (3*c*) and leading anteriorly from this the narrow seminal groove (3*s*). The anterior end of the seminal groove is in front of and below the right eye where it enters the male aperture (Fig. 11, *u*).

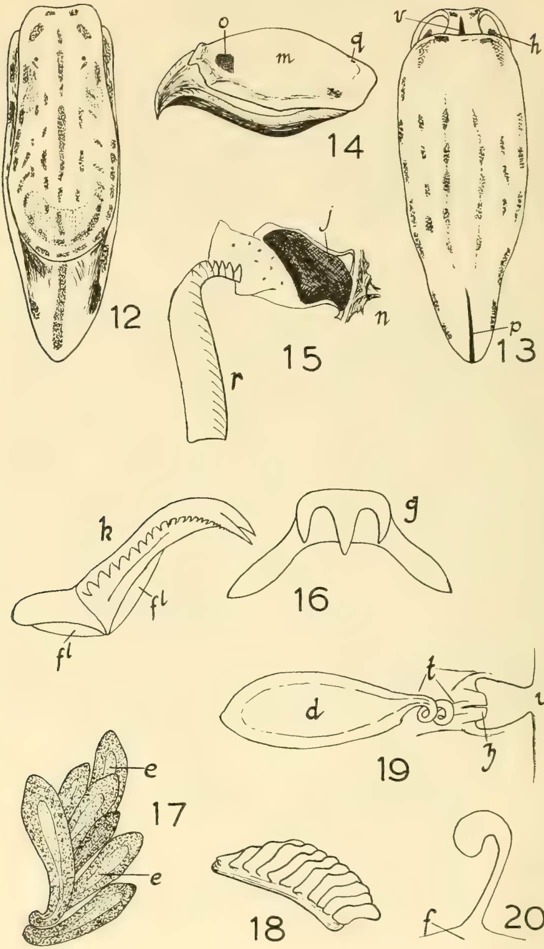
The body colour is greenish-black (like liquorice), the foot and mantle margins are an ashy yellow. The anterior corners of the dorsum and a small triangular area over the internal shell are similarly ashy yellow. There is no spotting whatsoever. The branchia is whitish, the sole of the foot is paler than the dorsum.

The preserved paratype is 1.5 mm. long and 1.2 mm. broad; the colour is opaque white with a subepidermally pigmented black dorsum. The large black eyes show through the anterior dorsum and a few larger cells with hyaline centres are visible from deep within the integument of the posterior part of the dorsum. The posterior of the dorsum is trilobed (Fig. 4) as a result of the forward

---

Fig. 1-11. *Runcina australis* spec. nov.

Fig. 1. Dorsal view of living animal, holotype specimen.
Fig. 2. Lateral view of same.
Fig. 3. Right lateral posterior of same.
Fig. 4. Dorsal view of preserved paratype.
Fig. 5. Buccal lining, jaws and radula.
Fig. 6. Radula from above.
Fig. 7. Lateral tooth.
Fig. 8. Gizzard plate.
Fig. 9. Detail of surface of same.
Fig. 10. Dorsal view of shell.
Fig. 11. Male copulatory organs.


o
m
q
v
h
14
j
n
12
p
13
15
r
k
g
f^l
16
f^l
t
u
d
z
19
e
17
e
18
f
20

contraction of the intestine and anus. With a large lobe either side of the smaller median one, the rear end of the paratype is now very similar to that of *R. prasina* (Morch 1863) (Bergh, 1872, pl. 24, fig. 27; Pilsbry, 1896, pl. 68, fig. 42) thus making this characteristic of the latter very suspect. In both the preserved material and *R. prasina* the tail is severely drawn forward until it is short and broadly rounded.

The buccal mass (Fig. 5) is enclosed within a cylindrical sheath of thin cuticle *(y)* and within this the jaws *(j)* and the radular strip *(r)* are readily observed. The jaws are dark red in colour, matt in texture from their composition of minute pointed elements; their shape is squatly triangular, not elongate flask-shaped as in *R. setoensis* (Baba 1954, p. 374, fig. 1, 4). The radular strip is dull yellowish and fairly evenly curved. When removed and flattened, about 30 rows of teeth were counted, each row with the formula 1.1.1. The rhachidian (Fig. 6, *g*) is narrow with a high bilobed cusp. The laterals (6 *k*) have broad bases with a somewhat philinid swan-necked cusp minutely denticulated along the inner edge.

The gizzard contains four hyaline plates (Fig. 8) each 0.1 mm. long within a muscular dilation of the alimentary tract. Their shape is not unlike that of *R. setoensis* (Baba loc. cit., fig. 1, C) but the base is not nearly so curved. There are 10-11 pairs of irregular denticles (Fig. 9) on each plate; these correspond with the plates in *R. calaritana* Colosi 1915 in the number of denticle-bearing laminae and the lateral shape but disagree in the less pronounced denticles.

The male copulatory organ (Fig. 11) is 1 mm. long; it extends from the right anterior male aperture to the left beneath the alimentary tract and then backwards to very near the female glands, thus occupying an even greater space than in *R. calaritana* (Pelseneer, 1894, pl. 7, fig. 59). Ectally the organ comprises a small atrium with a constricted aperture (*u*). Into the atrium projects a short conical penis *(z)* which surmounts the thick sphincter muscle at the ectal end of the duct from the prostate gland. This duct *(t)* is narrow and twisted and is absent from *R. calaritana* (Colosi 1915, p. 25, fig. 16; Vayssiére, 1883, pl. 2, fig. 13) but corresponds to that of *Ildica nana* (Bergh 1889, p. 872, pl. 82, fig. 37 *b*). The prostate gland *(d)* not cylindriform as in *R. calaritana* (loc. cit.), is fusiform with thick glandular walls and a narrow lumen. The inner end of the prostate gland narrows not to a sphincter as in *R. calaritana* but to a slender neck. Beyond the neck is the irregularly fusiform seminal vesicle *(dx)* with thinner softer walls and a larger lumen than the prostate. Its contents are yellowish viscid matters containing sectionally ovoid circular cells packed closely entally but further apart ectally. The seminal vesicle is very much larger than its counterpart in *R. calaritana* (loc. cit.; Pelseneer, 1894, pl. 7, fig. 59) and somewhat resembles the long prostate gland of *Runcinella zelandica* (Odhner 1924, pp. 49-50, fig. 8) in its shape and form of connection to the prostate gland.

The female gland mass has a single large white stalk-like cylindrical vesicle with a curled-over distal end. This is probably the bursa copulatrix (after Odhner, 1924, pp. 48-49, fig. 7-8, *b*) as it opens directly into the common genital aperture. (Fig. 3, *c*).

Fig. 12-20. *Ilbia ilbi* gen. et spec. nov.

Fig. 12. Dorsal view of living animal, holotype specimen.
Fig. 13. Ventral view of same.
Fig. 14. Lateral view of preserved holotype.
Fig. 15. Labium, jaws and radula.
Fig. 16. Radula.
Fig. 17. Opaline glandulae.
Fig. 18. Gizzard plate.
Fig. 19. Male copulatory organs.
Fig. 20. Bursa copulatrix.

From its terminal position over the anus (Fig. 4, x), the 0.1 mm. long shell was dissected out. Roughly shaped as in *R. setoensis* (Baba 1954, p. 373, fig. 1, B), the shell (Fig. 10) appears to be not as thin nor as elongate; it is calcareous.

Material examined: 1 specimen (holotype) from Point Danger, Torquay, Victoria, 2nd April 1960, collected by R. Burn, N.M.V. reg. No. F21,270; 1 specimen (dissected paratype) from the north side of Long Reef, New South Wales, 11th June 1961, collected by P. Colman, N.M.V. reg. No. F23,066.

Habitat: The holotype was found crawling among the roots of the green alga, *Caulerpa scalpelliformis,* and various minute brown seaweeds, on the side of a stone in a channel at the edge of the reef at Torquay. The paratype was found among the branches of a clumping green alga, *Valoniopsis,* which grows on the sides of rocks and walls exposed to the sea at Long Reef.

Discussion of *Runcina australis*

Odhner (1924, p. 51) listed five species as comprising the genus *Runcina.* To these Baba (1937, 1954) added two Japanese species, one of which (*R. elioti* Baba, 1937) is here removed from *Runcina* and made the type species of a new genus, *Runcinida,* for reasons given below. With the addition of the new species described above, the genus has seven species. Certain of these species, however, are undoubtedly identical. But the primary concern is the recognition of the characteristics of the valid type species of the genus and the correct name of the Mediterranean species. The type species is *R. coronata* (Quatrefages, 1844, p. 151, = *R. hancocki* Forbes, 1851, p. 612) from off the coast of Brittany and England. Unfortunately its anatomy is not known in detail but the excellent figures of the living animals (Alder and Hancock, 1846, pp. 289-292, pl. 4, fig. 1-7) provide a firm basis for the future recognition of the species.

However when the Mediterranean *R. coronata* (Vayssiére, 1883, pp. 6-28, pl. 1, fig. 1-12, pl. 2, fig. 13-22; 1885, pp. 104-106, pl. 5, fig. 126-129; Pelseneer, 1894, pp. 17-18, pl. 7, fig. 56-61, non text fig. F which is the type species) is compared with the type species, obvious differences are at once outstanding. Both Quatrefages' figure of *R. coronata* (Pilsbry, 1896, pl. 68, fig. 35) and those of Alder and Hancock show that a colour area extends across the anterior of the dorsum and backwards along either side until shortly behind the eyes where these colour areas turn medianly and join. Very definite colour areas encircle each eye and moreover the eyes show strongly through the dorsum. In the Mediterranean species (Vayssiére, 1883, pl. 1, fig. 1; 1885, pl. 5, fig. 126) the colour areas are limited to the anterior lateral corners of the dorsum only and do not join across the dorsum either in front of or behind the eyes, which it must be emphasised show very weakly dorsally. Another point of difference that is readily apparent is the shapes of the dorsa. In *R. coronata,* the sides of the dorsum are parallel from end to end while in the Mediterranean species the dorsum is widest at the second third and the anterior corners are a little expanded laterally. Of the internal anatomy only the gastral plates can be compared; *R. coronata* has six laminae (Alder and Hancock, 1846, p. 290, pl. 4, fig. 6) and the Mediterranean species has 10-11 laminae on each plate. Even with only these points of difference available, it is impossible to retain the use of the type name for the Mediterranean species. From the literature it is obvious that this latter species was re-described as *R. calaritana* (Colosi 1915, pp. 1-35, fig. 1-18); special agreement is shown in the gastral plates and the male copulatory organs, the former characterized by the sharp laminae and the latter by the short terminal seminal vesicle at the base of a long cylindriform prostate gland (loc. cit., p. 25, fig. 16). Pruvot-Fol (1954, p. 55) had already suggested that *R. calaritana* was a synonym of the Mediterranean species and pointed out that the earlier *R. capreenis* (Mazzarelli, 1893) could also be the same species. Unfortunately the original description of this last species is not available in Australia at the present time.

The valid species of *Runcina* are, then, as listed below:
R. coronata (Quatrefages, 1844). European Atlantic.
R. prasina (Morch, 1863). West Indies.
R. capreenis (Mazzarelli, 1893). Mediterranean.
R. inconspicua Verrill 1901. West North Atlantic.
R. calaritana Colosi 1915. Mediterranean.
R. setoensis Baba 1954. Japan.
R. australis spec. nov. South-eastern Australia.

R. australis must be grouped with those *Runcina* in which the dorsum is pyriform (broadest at the second third of its length) and the eyes show weakly dorsally. This group is typified by *R. calaritana*, from which the new species can be separated by a different colour pattern, details of the shape of the radula and a much longer seminal vesicle, shorter prostate gland and longer efferent duct. *R. coronata* typifies the second group of species with its strongly showing eyes and near parallel dorsum. To this group also belongs *R. setoensis* which differs in its very elongate shape, degenerate radula and 10-11 laminae. *R. inconspicua* has a broad foot much wider than the dorsum and *R. prasina* very prominent laminae upon the gastral plates. *R. prasina* and *R. inconspicua* have dorsally showing eyes and near parallel sides of the dorsum. Should both species be refound, it is not impossible that they will prove to be one and the same species. The trilobed posterior dorsum of *R. prasina* is as mentioned earlier, a very suspect characteristic in the light of preserved material of *R. australis;* fresh material would most likely reveal a rounded posterior dorsum as in *R. inconspicua* Verrill (1901, p. 28, pl. 3, fig. 6).

Ilbia gen. nov.

Runcinidae with a wide mantle all round and without any branchia or branchial vestige to the right or around the anus. Jaws present; radula with tricuspidate rhachidian and one denticulate bifid lateral tooth each side. Shell absent. Tail of foot with a conspicuous pedal furrow. Male copulatory organs with a short prostate gland. A large posterior dorsal opaline gland present.

Type species: *Ilbia ilbi* spec. nov.

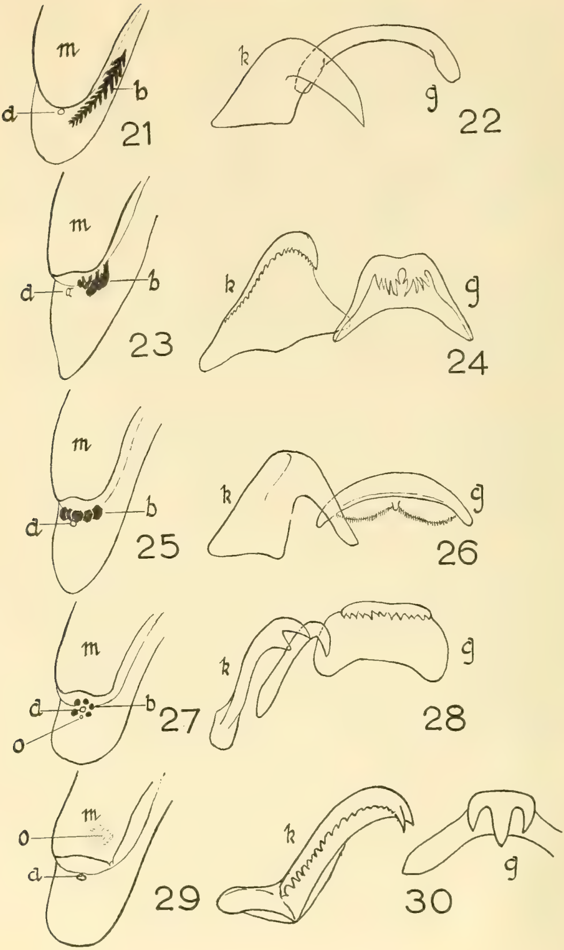
Ilbia ilbi spec. nov.

Figures 12-20

Alive the single specimen was 2.7 mm. long, 0.9 mm. broad and 0.75 mm. high. The dorsum (Fig. 12) is nearly square anteriorly although shallowly concave in the front margin, it is narrower than the foot and rounded posteriorly. The edge of the dorsum (mantle) is wide and overhangs all round except in front where the dorsum curves down into the head. The mantle has thickened edges which are curled downwards and touch the upturned foot edges, thus forming a funnel along either side of the body. The foot (Fig. 13) is rounded anteriorly and the actual front margin is shallowly concave; the edges are a little upturned; the tail comprises nearly one third the total length of the animal, it is narrowly rounded behind. The sole has a posterior middle-line groove, the pedal furrow *(p)* which extends forward from the tip to about the fourth fifth of the body length. The mouth *(v)* is a narrow vertical slit in the anterio-ventral dorsum. The small anus is high up under the posterior mantle, a very little to the right of the middle-line. There is no branchia. Anteriorly in the fold between the mantle and foot, there is on each side a distinctive elongate oval area of raised coloured flesh *(h)* which appears to be homologous with Hancock's organ in other suborders of Cephalaspidea. The eyes show dorsally and are small in size; immediately antero-laterally of each eye is a deep cylindrical pit leading to the eye. On the posterior right of the dorsum is a large quadrangular shallowly hollowed area (Fig. 14, *o*); this is the position of the opaline gland.

The entire dorsum, sides and sole of the foot are covered with vibratile cilia. This enables the animal to crawl along on a flat surface equally well either on the sole or the dorsum, or on the side when both surfaces are used. Apparently the cilia within the funnel-like fold on each side of the body divert the oxygen laden water to absorption areas within the lateral folds.

The body colour is pale purple, the viscera and eyes showing black dorsally.


m
b
d
21
k
g
22
m
d
b
23
k
g
24
m
b
d
25
k
g
26
m
d
b
o
27
k
g
28
m
o
d
29
k
g
30

The dorsum, sides of the foot and the sole are all patterned with yellow patches. On the dorsum there is a middle-line series of five longitudinal patches which attain neither the anterior nor the posterior edges of the dorsum. On either side of this but only in the rear part is a shorter series of smaller patches, again longitudinal. Lateral to these series is yet another series of patches, this time set obliquely to the longitudinal, across the posterior of the dorsum these series join and form an even curve. Around the very posterior of the dorsum is a row of patches which carry forward discontinuously along both lateral edges. Four pairs of patches are distinctively placed behind and in front of the eyes (Fig. 12). The sides of the foot have a few large patches, submarginally positioned around the edges and the tail crest bears a yellow streak. The sole (fig. 13) has patches submarginally (showing through from above) and four longitudinal series of epidermal patches, the median two series of which are connected subepidermally by a narrow strip of minute white pigment cells. Similar white pigment cells form areas on the dorsum, an elongate curved pyriform area rear lateral of each eye and a larger lunate area behind and above the black viscera. The anus is whitish at its aperture and the Hancock's organs are reddish orange.

Preserved specimen (Fig. 14) is 1.9 mm. long, 1 mm. broad and 1 mm. high. The colour is drab greyish-white, the tail and the sole are grey; the area around the right eye is black and both eyes show as an intense black spot. The shape has not altered a great deal overall, the tail has shortened a little. The pedal furrow (Fig. 13, *p*) is now more prominent. The edges of the foot and mantle are now more thickened, that of the foot curls over the mantle. The cilia of the skin are still visible through a medium power microscope, i.e. x40 and greater.

Fig. 21-22. *Ildica nana* Bergh 1889.
Fig. 21. Right lateral posterior of animal.
Fig. 22. Radula (both figures adapted from Bergh, 1889).

Fig. 23-24. *Runcina calaritana* Colosi 1915.
Fig. 23. Right lateral posterior of animal.
Fig. 24. Radula (both figures adapted from Vayssière, 1883).

Fig. 25-26. *Runcinida elioti* Baba 1937.
Fig. 25. Right lateral posterior of animal.
Fig. 26. Radula (both figures adapted from Baba 1937).

Fig. 27-28. *Runcinella zelandica* Odhner 1924.
Fig. 27. Right lateral posterior of animal.
Fig. 28. Radula (both figures adapted from Odhner, 1924).

Fig. 29-30. *Ilbia ilbi* gen et spec. nov.
Fig. 29. Right lateral posterior of animal.
Fig. 30. Radula.

ABBREVIATIONS

Figs. 1-30.

a — dorsum.
b — labium.
c — opaline gland.
d — pedal furrow.
dx — eye.
e — radula.
f — seminal groove.
fo — penial coils.
fl — atrium.
g — mouth.
h — shell area.
j — cuticularized buccal lining.
k — penis.
m — anus.
n — branchia.
o — common genital aperture.
p — prostate gland.
q — seminal vesicle.
r — lumen of opaline glandulae.
s — female gland mass.
t — foot.
u — flange.
v — rhachidian tooth.
x — jaw.
y — lateral tooth or teeth.

The labium (Fig. 15, *n*) is brown in colour, thickly cuticularized with about six strong radial grooves about its flange; it lines the inner wall of the mouth and is attached to the anterior edge of the cuticle bearing the jaws. The jaws *(j)* are 0.4 mm. long in the major axis, pale yellow in colour, elongate triangularly oval in shape and composed of large scale-like diamond-shaped elements set obliquely upon their bases. A few elements of various shapes and sizes are scattered over the cuticle between the jaws and the radula. The colourless radula *(r)*, crook-shaped with the neck foremost and 0.7 mm. in length, consists of 25-26 rows of teeth of the formula 1.1.1. The rhachidian is tricuspidate (Fig. 16, *g*) and has a broad base with wing-like arms; as a whole, the rhachidian is closer to that of the aplysiid *Phyllaplysia,* in particular that of *Ph. engeli* (Marcus 1955, pl. 4, fig. 33, *m*) and somewhat that of *Ph. lafonti* Crosse 1872 (Pilsbry, 1896, pl. 9, fig. 26). The lateral tooth *(k)* on each side of the rhachidian, is a combination of the denticulate philinid lateral of *Runcina* (loc. cit., pl. 68, fig. 36) and the bifidate cusp of the marginal tooth of *Runcinella zelandica* Odhner (1924, p. 46, fig. 6). A thin flange *(fl)* is present on the rear side of the tooth proper and its base. The 15-20 denticles on the leading edge of the tooth are larger and stouter nearer the base; upon the cusp they are smaller, narrower and closer together.

The gizzard plates (Fig. 18) are slightly curved and armed with 8-10 low blunt transverse laminae, each with two high points. The high points form two distinct series, one on each side of the middle-line. As usual in the Runcinacea (Thiele, 1935, p. 1050), four gizzard plates are present.

Anteriorly the genital organs comprise the male copulatory organ (Fig. 19) which occupies the anterior of the visceral cavity below the buccal mass. This organ consists of a relatively large atrium *(u)* into which the shallow seminal groove enters. Into the distal portion of the atrium projects the short cylindrical penis *(z)* the base of which is contained within the muscular walls of the atrium. The penis is connected from its basal part by a narrow duct *(t)* with lightly muscled walls and a double spiral in its course to a short dilated penial prolongation, the prostate gland *(d)*. The walls of this are thick and glandular, the cavity is spacious. A seminal vesicle, as present in *Runcina australis,* is lacking.

In the female gland mass, the yellow-orange granular follicles of the hermaphrodite gland are spread in clusters over the anterior of the colourless liver. As in *Runcina australis* and *Runcinella zealandica* (loc. cit., pp. 48-49, fig. 7-8 *b*), a bursa copulatrix (Fig. 20) opens directly into the common genital aperture; here it is similar to that of the former species in that it has a relatively short stalk and a curled-over distal end. From the anterior side of the common genital aperture the seminal groove issues forth and rises up towards the mantle. Its sides are low ridges rather far apart.

The opaline gland (Fig. 17) whose place of attachment has been mentioned previously (Fig. 14, *o*) in the description of the body, is a large, peculiar structure. Between 100 and 150 separate glands are present in a compact mass attached to the inner side of the posterior dorsal surface; many are twisted around others and all are apparently pervious through minute apertures in the dorsal surface. Each gland has thick yellowish glandular walls; the lumen of each *(e)* is narrow and filled with pale viscid fluid. In shape the glands are elongate fusiform with somewhat straight sides, the greatest diameter is just below the tip. The tip of each is bluntly conical. Overall the structure of the opaline gland is very similar to that of *Aplysia punctata* (Hoffman, 1932-1939, pp. 470-471, fig. 344, B, fig. 345, A, after Mazzarelli 1889) but is considerably narrower as in *Akera bullata* (loc. cit., fig. 344, D, after Perrier and Fischer 1911).

Material examined: 1 specimen (holotype) from Point Lonsdale, Victoria, 10th September 1961, collected by R. Burn and M. Pilbeam, N.M.V. reg. No. F23,062.

Habitat: The specimen was collected from the alga *Enteromorpha* (cf. *intestinalis)* which grows on the sides of a shallow sandy-bottomed rock pool near the highest part of the littoral zone.

Discussion of *Ilbia ilbi*

The striking body coloration and patterning of the living animal, the lack of a branchia, the tricuspidate rhachidian, the opaline gland and the pedal furrow are the characteristics to be used in distinguishing *I. ilbi* from all Runcinacean species. The undivided dorsum, posterior near middle-line anus, gizzard plates and genital organs unquestionably identify the genus and species as belonging to the Runcinacea. The lack of a branchia indicates that the genus deserves the highest position in the classification of the suborder (see discussion on systematic classification of the Runcinacea). The type of rhachidian and the dorsal opaline gland point to an even higher position for *Ilbia* than *Runcinella* which Odhner described as "a more advanced and specialized type . . . than *Runcina*" (1924, p. 51), and suggest a close affinity with the Anaspidea, particularly the Aplysiidae Dolabriferinae.

Both the generic and specific names of *Ilbia ilbi* are derived from the monogram of the writer's brother, Ian Lee Burn.

THE SYSTEMATIC CLASSIFICATION OF THE RUNCINACEA

Because of the small number of genera and species hitherto attributed to the Runcinacea, no systematic classification of the suborder has been felt necessary. Bergh (1889, pp. 868-869), Pilsbry (1896, pp. 170-171), Odhner (1924, p. 51), and Thiele (1931, p. 394) merely grouped *Runcina* and *Ildica* together in the case of the first two writers and in the case of the second two writers added *Runcinella* with the note that this latter genus is more advanced and specialized than *Runcina*. From the literature examined, it is evident that a clear and concise systematic classification based on several natural characteristics is readily available for the suborder. The following text indicates the reasonings for the various new proposals and is based largely on the ideas propounded by Nils Hj. Odhner in his works on the Opisthobranchia.

It is quite obvious that of all species of Runcinacea one stands apart. *Ildica nana* Bergh (1889, pp. 870-872, pl. 82, fig. 27-38) with an external shell, a long branchia on the rear right side and an arcuate rhachidian tooth is this species. As all other species have either an internal shell or none at all, an abbreviated branchia and a denticulate or tricuspidate rhachidian tooth, it is necessary to decide which is the more primitive, *Ildica* or the second group. Odhner's conceptions regarding evolutionary changes for the systematic classification of the Opisthobranchia (1939, pp. 3-25), i.e. that the degeneration of a part of an animal together with a strong tendency towards detorsion of both shell and animal among the more primitive forms is evidenced in a natural step forward, can well be applied to the Runcinacea. The presence of a relatively strong external shell in *Ildica* indicates that it is more primitive than *Runcina* which has an internal shell. Similarly *Runcina* has to be considered more primitive than those species (and genera) in which a shell is totally absent. Thus it is evident that *Ildica nana* is the most primitive Runcinacean and that the genus *Runcina* follows as next in succession.

However with the complete degeneration of the shell in the evolutionary scale above *Runcina*, this characteristic is of no value whatsoever. Therefore another characteristic, this time a little more subtle in its changes towards degeneration, is selected. The branchia offers everything desired for a complete classification.

Although it is already decided that *Ildica* is the most primitive genus and *Runcina* is the next most primitive genus, it serves well to use these genera as pointers to the succession of changes apparent within genera in the form of the branchia. In *Ildica* (Fig. 21) the branchia *(b)* is an elongate elegant plume with small pinnulae alternately placed on either side of the rhachis; its point of origin is the second third of the body length and it projects considerably beyond the right posterior margin of the dorsum. Generally speaking the branchia resembles that of the Pleurobranchacea both in shape and position. Between *Ildica* and *Runcina* considerable change in the shape, type and position of the branchia have occurred. Instead of the pinnulated plume the pinnulae arise separately from the body wall without any external interconnections. They are

also very severely reduced in number, e.g. three pinnulae in *R. australis* spec. nov. (Fig. 3, *b*) and *R. coronata* (Quatrefages 1844; Alder and Hancock, 1846, pl. 18, fig. 5), four pinnulae in *R. caloritana* Colosi (1915) (Fig. 23, *b*) and *R. setoensis* Baba (1954, p. 373). In the change of position, it is very evident that a terminal movement has begun. This is further confirmed from a study of the remaining Runcinids.

Among the species attributed to *Runcina,* one species (*R. elioti* Baba) deserves special attention because of its remarkable branchia and its type of radula. Although Baba's description of the branchia (1937, pp. 202-204) is very brief, the "several plumes arranged in a semi-circle, and lies in the median line beneath the posterior end of the mantle" (Fig. 25) indicates that it is not at all similar to the branchia of *Runcina.* Thus it can be seen that a definite movement has taken place in a posterior direction. The pinnulae apparently arise separately from the terminal body wall and they are spread evenly either side of the middle line (loc. cit., pl. 4, fig. 4). As the radula has non-denticulate lateral teeth in contradistinction to denticulate ones in *Runcina, R. elioti* cannot be accepted within the genus and deserves to be generically separated from that genus. *Runcinida* gen. nov. is proposed for this species and it is the type species by monotypy.

By the understanding of the change from the branchia of *Runcina* to that of *Runcinida,* the doridiform arrangement of the pinnulae (again arising separately from the terminal wall) in *Runcinella* Odhner (1924, pp. 48-49, fig. 7-8, *a;* Fig. 27) can be seen as the condition occurring after the lateral pinnulae move ventral-wards. There is also a reduction in the size of the pinnulae indicating another instance of the gradual degeneration of the branchia. The two lateral teeth on each side of the rhachidian in the radula and the presence of an infra-anal sac containing the glandulae of the opaline gland (loc. cit., p. 50, fig. 7, *e;* Fig 27, *o*) are the characteristics validating the genus. In *Ilbia* on the other hand, there is no branchia present at all but the cilia of the body walls within the funnels formed by the folding of the foot and mantle margins towards each other undoubtedly act as guides to respiratory absorption areas. Once more the details of the radula and the presence of an opaline gland distinguish the genus from other Runcinids.

The opaline glands of both *Runcinella* and *Ilbia* do not appear to differ at all morphologically. Although smaller and far more numerous in the latter, both genera have the individual glandulae similarly shaped and with walls composed of gland cells. The outer cutaneous sheath of the glandulae in *Runcinella* is no more than a deeply folded skin thus in both genera the glandulae are pervious to the surface although in *Runcinella* enclosed in an infra-anal sac. Colosi (1915) recorded the presence of an anal gland in *Runcina calaritana* (Hoffman, 1932-1939, pp. 494-495, Fig. 360, A); this appears to be the first indication of an opaline gland in the Rucinacea although it is vestigial in its extent as shown by the glandulae clustered around the central duct which is the only opening to the surface. It would appear that the Runcinacea are the systematically highest of all the Cephalaspidean suborders with some close similarities to the order Anaspidea where opaline glands are present in both families (Akeratidae and Aplysiidae). Hoffman (loc. cit.) calls the opaline glands of *Runcina calaritana* and *Runcinella zelandica* "analdrüsen" but through comparison with the glands of *Ilbia,* they must be considered as opaline glands.

Peculiarly enough the shape of the radular teeth shows some similarities throughout, particularly at generic level. *Ildica* (Fig. 22) with its arcuate rhachidian and non-denticulate hamate lateral is much the same as *Runcinida* but in addition the latter had an inner bilobed flange minutely denticulated along the edges and a small median cusp (Fig. 26). In *Runcina* (Fig. 24), *Runcinida* (Fig. 26) and *Runcinella* (Fig. 28) the rhachidian is medianly divided but in the latter two genera successively less strongly. The tricuspidate rhachidian of *Ilbia* appears to be derived from the multidentate bicuspidate rhachidian of *Runcina* and the median cusp of *Runcinida.* The lateral reduction of the denticles on each cusp of *Runcina* plus the building up and strengthening of the median cusp of *Runcinida* would result in the rhachidian of *Ilbia.* While the gastral plates of the Runcinacea are less strongly developed homologies of the gastral

plates of the Scaphandracean Cephalaspidea, family Atyidae (Pilsbry, 1896, p. 237, frontispiece, fig. 8; Marcus and Marcus, 1959, p. 882, fig. 9-12), only three plates are present in that family as compared with four throughout the Runcinacea. Gastral plates are also present in certain other families of Cephalaspidea (Phanerophthalmidae and Philinidae; loc. cit., pp. 884-892, fig. 23-24), but are again three in number and lacking in strong transverse denticulated laminae.

From the discussion of the Runcinacean genera and the evolutionary sequence of them, certain major divisions can be separated off. Primarily two divisions are seen in the external shell, pinnulate branchia and non-denticulate rhachidian of *Ildica* and the internal shell or lack of one, the branchia consisting of separate pinnulae or lack of same and the denticulate or cuspidate rhachidian of the remaining genera. For both divisions, family status is proposed, Ildicidae fam. nov. for the former and Runcinidae (Gray; Pilsbry, 1896, p. 17) for the latter. The second division (Runcinidae) can also be separated into two subfamilies, Runcininae for those genera with branchia and a denticulate rhachidian and Ilbinae for those without branchia and a cuspidate rhachidian. Briefly the suborder, families, subfamilies and genera can be diagnosed as follows:

Suborder RUNCINACEA

Cephalaspidea in which the dorsum is not divided transversely, the foot is without parapodia and the anal opening is terminal and just to the right of the middle line. The gizzard contains four laminated gastral plates. Jaws are present. Branchia when present posterior right or terminal in position between mantle and foot.

Family Ildicidae fam. nov.

Runcinacea with an external terminal shell, a pinnulated branchia and a non-denticulate rhachidian.

Genus *Ildica* Bergh (1889, pp. 869-870).

Branchia on posterior right of body wall. Minute oral tentacles present. Penis elongate cylindrical; prostate gland present. Radula with an arcuate rhachidian bearing a reduced denticle near each side and a smooth hamate lateral each side of the rhachidian.

Type species: *I. nana* Bergh (1889).

Family Runcinidae

Runcinacea with or without a terminal rudimentary internal shell, the branchia when present consisting of individual pinnulae and a denticulate or cuspidate rhachidian.

Subfamily Runcininae

Branchia present. Rhachidian bilobed, denticulate.

Genus *Runcina* Forbes (1851, p. 611)

Branchia consisting of 3-4 pinnulae to right of anus. Shell present. Prostate gland and terminal seminal vesicle present on male copulatory organ. Rhachidian deeply bilobed with each lobe denticulate, lateral tooth on each side of rhachidian denticulate, whole radula generate in one species. Opaline gland, composed of glandulae emptying into a central duct, present in one species at least.

Type species: *R. coronata* (Quatrefages 1844).

Genus *Runcinida* gen. nov.

Branchia consisting of a few pinnulae in a semi-circle beneath the posterior mantle. Shell not known, probably absent. Male copulatory organ not known. Radula with bilobed minutely denticulate rhachidian which also has a minute median cusp, and a smooth hamate lateral each side of the rhachidian. Opaline gland not known.

Type species: *R. elioti* (Baba 1937).

Genus *Runcinella* Odhner (1924, pp. 46-47).

Branchia consisting of 4-5 pinnulae doridiformly arranged around the anus. Shell absent. Male copulatory organ with prostate gland but lacking seminal vesicle. Rhachidian weakly bilobed, a simple hook-shaped tooth and a bicuspid larger tooth present on each side of the rhachidian. Opaline gland opening into an infra-anal sac.

Type species: *R. zelandica* Odhner (loc. cit.).

Subfamily Ilbiinae subfam. nov.

Branchia absent. Rhachidian tricuspidate.

Genus *Ilbia* gen nov.

Shell absent. Male copulatory organ with prostate gland but lacking seminal vesicle. Rhachidian with large cusps, the lateral tooth on each side of the rhachidian denticulate and bifidate. Opaline gland posterior dorsal, each glandula with its own aperture.

Type species: *I. ilbi* spec. nov.

SUMMARY

For the first time, Runcinacean gastropods are described and recorded from Australia. Two new genera are proposed, *Runcinida* for *Runcina elioti* Baba (1937) from Okinawa and Japan and *Ilbia* for *Ilbia ilbi* spec. nov. from Victoria, Australia. Two new species, *Runcina australis* and *Ilbia ilbi*, are described from Victoria and New South Wales. A systematic classification of the suborder Runcinacea is proposed with two families, Ildicidae and Runcinidae, the latter with two subfamilies, Runcininae and Ilbiinae. The five known genera are briefly described.

REFERENCES

Alder, J. and A. Hancock. 1846. Notices of some new and rare British species of Naked Mollusca. *Ann. Mag. Nat. Hist.*, 18, pp. 289-294, pl. 18.

Baba, K. 1937. Opisthobranchia of Japan (1). *J. Dept. Agric. Kyushu Imp. Univ.*, 5 (4), pp. 195-236, pl. 4.

——. 1954. *Runcina setoensis,* a new and rare species from the Coast of Kii, Middle Japan (Opisthobranchia). *Publ. Seto Mar. Biol. Lab.*, 3 (3) pp. 373-374.

—— and I. Hamatani. 1959. The Direct Development in *Runcina setoensis* Baba (Opisthobranchia-Cephalaspidae). *Ibid.*, 7 (2), pp. 281-29, pl. 22-24.

Bergh, R. 1872. *Malacologische Untersuchungen* (C. Semper, Reisen im Archipel der Philippinen), 1 (4), pp. 175-203, pl. 21-24.

——. 1889. *Ibid.*, 3 (16, ii), pp. 815-872, pl. 82-84.

Forbes, E. 1851. In *A History of British Molluscs and their Shells,* 3, pp. 611-612, pl. CCC, fig. 2.

Hoffman, H. 1932-1939. Opisthobranchia. Bronn, *Kl. Ordn.*, 3, Abtlg. II, Buch 3 (1), xi + 1247 pp., 1 pl.

Marcus, E. 1955. Opisthobranchia from Brazil. *Bol. Fac. Fil. Univ. S. Paulo, Zool.* No. 20, pp. 89-200, pl. 1-30.

Marcus and E. Marcus. 1960. Opisthobranchia aus dem Roten Meer und den Malediven. *Ak. Wiss. Lit. Mainz,* 1959 (12), pp. 871-934.

Odhner, N. 1924. New Zealand Mollusca. *Vidensk. Medd. fra Dansk n. h. Foren. Kobenhavn,* 77, pp. 1-90, pl. 1-2.

——. 1926. Die Opisthobranchien. *Further Res. Swed. Antaret. Exped.* 1901-1903, 2 (1), pp. 1-100, pl. 1-3.

——. 1939. Opisthobranchiate Mollusca from the western and northern coasts of Norway. *K. Norske Vidensk. Selsk. Skr.*, 1939, No. 1, pp. 1-93.

Pelseneer, P. 1894. Recherches sur divers opisthobranches. *Mem. Cour., Cl. Sci. Nat. Acad. Roy. Belgique,* 53, 3 + 157 pp., pl. 1-25.

Pilsbry, H. 1896. *Manual of Conchology,* by G. W. Tryon, Jr., 16, pp. 111-262, pl. 1-74.

Pruvot-Fol, A. 1954. *Faune de France,* 58: Mollusques Opisthobranches. 448 pp., 173 fig. Paris (Paul Lechevalier).

Quatrefages, A. 1844. Mémoire sur les gastéropodes phlébéntéres (Phlebenterata Nob.), ordre nouveau de la classe des gasteropodes. *Ann. Sci. Nat. Zool.*, (3), 1, pp. 129-133, pl. 3-6 (not seen).

Thiele, J. 1931. Opisthobranchia. *Handb. Syst. Weichtierkunde,* 1, pp. 377-461.

——. 1935. *Ibid.*, 2, pp. 1123-1154.

Vayssière, A. 1883. *Ann. Sci. Nat.* (6), 15, p. 6.

——. 1885. Recherches Zoologiques et Anatomiques sur la Opisthobranches du Golfe de Marseille, I. *Ann. Mus. Hist. Nat. Mars. Zool.*, 2, Mem. 3, pp. 1-180, pl. 1-6.

Verrill. A. 1901. Additions to the fauna of the Bermudas, etc. *Trans. Conn. Acad. Arts. Sci.*, 11 (1), pp. 15-62, pl. 1-9.

The larvae of *Gynacantha mocsaryi* Forster and *Hydrobasileus brevistylus* (Brauer) (Odonata)

By F. C. FRAZER, F.R.Z.S.

Some thirty-six species of larvae of Australian Odonata have been described so far, for the greater part by the late Dr. R. J. Tillyard. It is evident from his venational studies of the wings of Odonata, that he had at one time a number of larvae which he never described and it is the more unfortunate that all these appear to have been lost. In this paper, the larvae of two more species are described from material which I found in Mr. R. Dobson's collection. One of these, the larva of *Gynacantha moscaryi* Forster, is of unusual interest in that only two other species belonging to this large genus have been described so far, one of which, *dobsoni* Fraser, is also Australian. Another feature also lends interest to this larva, in that it now confirms that all larvae of this genus possess setae on the lateral lobes of the labium and so differ markedly from all other genera of the family Aeshnidae. Tillyard was the first to point out this character and from it he surmised that the Gynacanthas were the most recent of the Aeshnidae, thus differing from the opinion expressed by Butler (1904, *Trans. Amer. Ent. Soc.* 30; 111-134) who regarded the genus as the most archaic. The latter pointed out that the early instars of larvae of most of the Aeshnidae possessed setae which were shed in later instars. It is to be remembered that Tillyard reversed his theories on the evolution of Odonata in later years and I feel sure that he would have then shared Butler's opinion as to the true place of the genus *Gynacantha* in the family Aeshnidae.

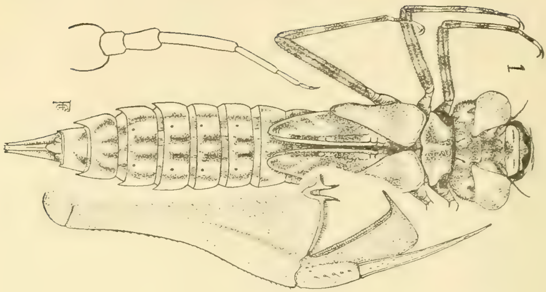
The early instars of larvae of *Gynacantha* are unknown so that it is not possible to say whether they possess setae on the labium or not.

Gynacantha mocsaryi Forster. (Fig. 1.)

Material examined: exuviae of larvae obtained at Helenvale near Cooktown, N. Queensland, and bred to the imaginal stage at Wahroonga, N. S. Wales by R. Dobson; 25. i. 51 to 7. iii. 51.

Total length 40 mm. Width of head 9 mm. Greatest breadth of abdomen 7 mm.

Head rather flat on dorsum, approaching that of *Anax;* eyes protuberant, prolonged and tapering inwardly and posteriorly as viewed from above; postocular lobes rounded, coarsely spined, the hinder margin shallowly concave; ocelli not apparent. Labium kite-shaped, flat, tapering posteriorly to as far as mesocoxae; median lobe convex with a median V-shaped cleft bounded on each side by a long outwardly curving spine; the rest of the free border fringed with coarse hairs. Lateral lobes of Aeshnine build, with broadly squared apex, the outer angle slightly rounded, the inner prolonged into a stout spine which with its opposite fellow, fits into the V-shaped cleft when the lobes are apposed; the inner margin fringed with closely-set, rectangular teeth. Movable hook long and robust, with several small setae present on the basal half. Below the hook a row of short but conspicuous setae, five in number, and at base of lobe a cluster of four or five smaller setae. Prothorax narrower than head, ruff-shaped, broadening posteriorly and obtusely pointed laterally, its posterior border sinuous and slightly emarginate; a robust obtusely pointed lobe anteriorly and laterally. Meso- and metathorax pyriform, its surface undulate; wing-pads meeting at middle line, extending to the 4th abdominal segment, broad and flat, irregularly pigmented, especially along the costal portion of wings. Legs longer than is usual for the Aeshnidae, four-sided with finely spined ridges separating the surfaces; both femora and tibiae with three dark encircling bands; the second segment of the tarsus also darkened. Abdomen elongate fusiform, flattened ventrally, rounded



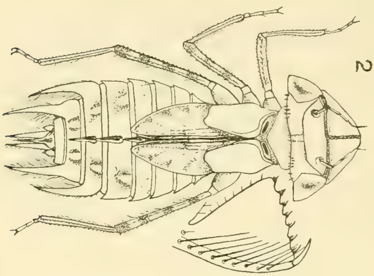


Figure 1.—Larva of *Gynacantha mocsaryi* Forster. Inset, the right half of labium and antenna.

Figure 2.—Larva of *Hydrobasileus brevistylus* (Brauer). Inset, right lateral lobe of labium.

or arched dorsally, with four broken lines of dark pigment forming a pattern extending from segment 4 to 10; no dorsal spines but conspicuous ones on the sides of segments 7 to 9, gradually lengthening and longest on segment 9. Anal appendages: appendix-dorsalis 3 mm., slightly bifid at its apex; cerci of almost the same length, acute at apices; cercoids shortly conical, all processes closely apposed to form a conical apex to the abdomen.

This larva differs from that of *dobsoni* by the setae on the lateral lobes of labium being very much shorter and by the extra and small setae on the movable-hook.

Gynacantha dobsoni Fraser.

Gynacantha rosenbergi Tillyard nec Brauer 1916. *J. Linn. Soc. Lond.* 33: 71.

The larva of this species was described by Dr. Tillyard as that of *rosenbergi,* but it is evident from his description of the imago, that he had made an incorrect identification, *dobsoni* not being known at that date. *G. rosenbergi* is a much larger and more robust species than *dobsoni* and is readily distinguished by the broad area of amber tinting at the base of the hindwings from all other species of *Gynacantha.*

Hydrobasileus brevistylus (Brauer).

Material examined: exuviae in the Dobson collection from the Barron River, Kuranda, N. Queensland; 30. ix. 53.

Total length 23 mm. Width of head 8 mm. Greatest breadth of abdomen (segments 6 and 7) 9 mm.

Head triangular, eyes forming sharp angulations of the posterolateral aspects, their posterior border almost in line with the occipital which latter is widely but shallowly emarginate and beset with numerous short spines; these latter forming a group of four on each side and two more robust ones just internal to the eyes. Antennae of seven segments, the base short and broad, the remaining segments slim, elongate, gradually shortening to as far as the apical segment. Labium broad and deeply cupped, the middle lobe with a curved row of twelve long setae, its anterior border strongly and angularly convex, without cleft, the border fringed with widely spaced moderately long setae. Lateral lobes triangular, posterior border with a few widely spaced short setae similar to those on the middle lobe; outer border with a moderately long movable hook and nine long setae; on the inner side of the proximal seta, a small isolated one. Inner border with seven crenulations each with one long and two short setae. Prothorax transversely triangular, meso- and metathorax short and robust. Wing-pads broadly triangular, meeting in the middle line over dorsum, extending posteriorly to as far as the apical border of the sixth segment. Abdomen almost flattened ventrally but rather strongly arched dorsally, broadly elliptical in outline; segments 4 to 5 with short middorsal spines, sixth to eighth with much longer and more robust spines, their apices strongly curved posteriorly to overlap the segments behind; short lateral spines on segments 3 to 7 but of great length and robustness on 8 and 9, both of which overlap widely segment 10 as if to form a protective barrier to the anal appendages; all these spines thickly fringed with hairs. Anal appendages very hairy; the appendix-dorsalis broad at base then slim and tapering; cerci slim, longer than the appendix-dorsalis, their apices in line with the lateral spines of segments 8 and 9. Legs slim, rather long, hind femora extending to apical border of segment 7, four-sided and with narrow minutely spined ridges separating the surfaces. General colouring yellowish but probably pale green during life with but faint marbling on terminal segments of abdomen and three to four dark rings on the femora, barely visible on the anterior pair.

The Rediscovery of *Synlestes weyersi* (Odonata: Chlorolestidae)

By F. C. Fraser, F.R.Z.S.

Synlestes weyersi was described by Selys (1868) from a single female collected by Weyers. The habitat was given as Port Denison and it is important to note that the same habitat was given for the species *Hemiphlebia mirabilis* Selys, some twenty specimens of which were also presented to Selys by Weyers. As will be seen hereafter, both species were ultimately discovered in Victoria, from which fact we are led to infer that from lack of data on the specimens Selys gave the name of the port from which the specimens were sent to him, and that the two species were actually collected by Weyers in Victoria.

Selys stated that along with these two species four other Odonates were included as well as a new Panorpid viz.: *Cordulia (Synthemis) eustalacta* (Burmeister), *Aeshna brevistyla* Rambur, *Lestes analis* Rambur, *Agriolestes (Agriolestes) icteromelas* Selys and *Bittacus nigriceps* Selys, the habitat of the latter being again given as Port Denison.

Selys described what he thought to be the male of *S. weyersi*, this being quite natural as only the one species was known at the time and the wealth of others afterwards discovered not even suspected. At the same time, the female was again described, emphasis being laid on the fact that the juxtahumeral orange stripe was broader than in the described male, in which it occurred as a fine line only, incomplete both above and below, but nearly complete in the female type.

In 1948, by the courtesy of the authorities of the Musée Royal d'Histoire Naturelle de Belgique, I was enabled to examine both the type female and the supposed allotype male, as a result of which, and because of the striking differences in the markings of the thorax, I came to the conclusion that the two were not conspecific; I accordingly redescribed the male as a new species under the name of *S. tillyardi* (Fraser 1948).

Recently, whilst enjoying the great hospitality of my friends Mr. and Mrs. Dobson in Jersey, I was afforded the rare opportunity of examining the rich collection of Odonata which he amassed in Australia; it is probably quite the largest and most representative of its kind, containing both new material and a wealth of data as to habitats and distribution of species. Among a long series of *Synlestes tillyardi*, I was delighted to find a single male, which, from its markings. I at once recognized as the opposite sex of the single female *weyersi* in the Selysian collection. After nearly a century, it had at last been discovered! The broad orange-coloured juxtahumeral stripe, so similar to that of the female, left no room for doubt. The data on the specimen read—"Yinnar, Victoria, 24. iv. 48. J. H. Courtenay," and now that the true habitat was known, it seemed highly probable that more specimens might be obtained. The description of the male and its differentiation from other species, especially from *tillyardi*, follows.

Synlestes weyersi Selys.

Synlestes weyersi Selys, 1868, *C. R. Soc. Ent. Belg.* 11: 76; *Id.* 1886 (pars), *Mem. Cour. Acad. Belg.* 38: 91; Kirby, 1890, *Cat. Odon:* 126; Fraser, 1948. *Bull. Mus. R. d'Hist. Nat. Belg.* 24: 2-4, figs. 1, 2.

Male. Abdomen 43 mm. Hindwing 28 mm.

Head: labium and bases of mandibles pale yellow; labrum, anterior and posterior clypeus, frons, vertex and occiput dark blue metallic, the genae glossy black with slight metallic lustre. The occiput behind presenting an obtuse nipple-like prominence on both sides. Eyes dark reddish brown but may be dark blue in life ? Prothorax chrome yellow, the middle lobe with two dark bronzed black areas, triangular in shape and confluent at a point over the middorsum. Posterior lobe entirely pale yellow, trilobate. Anterior border of mesothoracic lamina narrowly bordered with pale yellow. Thorax on dorsum, to as far lateral as the first lateral suture, dull steely dark purplish or coppery metallic marked with a broad juxtahumeral stripe of dark ochreous or even ferruginous in colour. narrowed and partly forked at its lower end. deficient in its uppermost part which

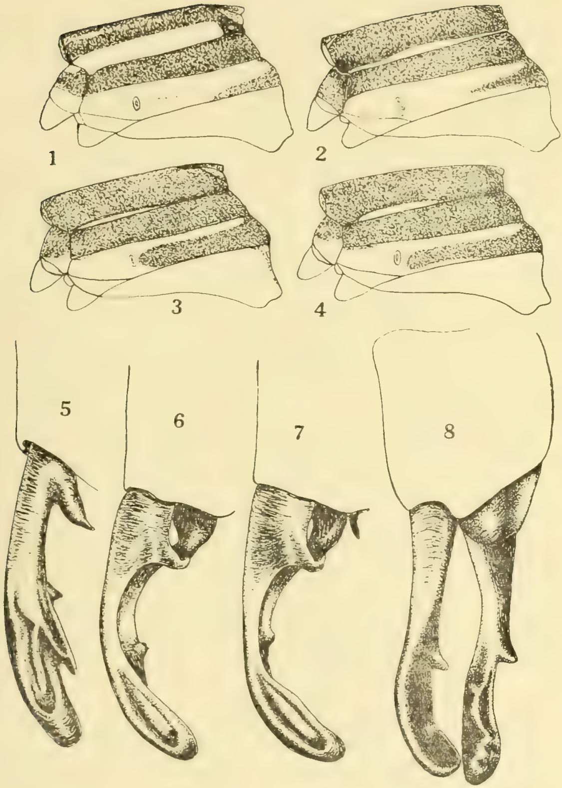


Fig. 1. 1 to 4, Left lateral view of thoraces of *Synlestes* to show extent of metallic green markings. 1. *Synlestes weyersi* Selys, from the type male, 2. *Synlestes selysi* Tillyard, 3. *Synlestes nigrescens* Tillyard (The humeral stripe may be quite absent), 4. *Synlestes tillyardi* Fraser. 5 to 8, Male anal appendages of,—5. *Synlestes selysi* Tillyard, 6. *Synlestes nigrescens* Tillyard, 7. *Synlestes tillyardi* Fraser, all dorsal views of the left appendage, 8. *Synlestes tropicus* Tillyard, right latero-ventral aspect.

is taken by a black area enclosing a small yellow point. Laterally bright yellow, paler over the metepimeron and with a complete dark stripe of coppery metallic on the second lateral suture. Beneath yellow, thinly pruinosed. Legs dark reddish brown, black on the flexor surfaces. Wings hyaline, pterostigma dark reddish brown with a pale lining on costal and posterior borders, braced, covering 4 cells, about 2½ times as long as broad, convex posteriorly. Nodal index, 18 to 19 postnodals in forewings, 14 to 16 in the hind; anal vein fusing with posterior border of wings beneath the discoidal cell, nearer its apex than its base; 3 postdiscoidal cells. Abdomen long and narrow, dark steely purplish black on dorsum but a duller black on terminal segments; segment 1 yellow at extreme base, segments 3 to 6 with basal yellow points not confluent over middorsum; the sides of segments 1 and 2 and base of 3 laterally pale yellow; beneath dull yellow infuscated with brown, the terminal segments rather paler beneath. Anal appendages black, slightly longer than segment 10, the inferiors only about one fourth the length of superiors which are forcipate, broad at base and again at apex, presenting a very robust basal medial spine with its apex slightly curved ventrally and not differing markedly from other related species; no ventral spine or tubercle on the middle of superiors, the apical third expanded somewhat spatulate-like and grooved on both upper and lower sides, the inner side slightly protuberant and furnished with short stiff hairs or bristles. Inferior appendages markedly divaricate, broad at base, then constricted and again expanding ovulate. hairy.

Female. Abdomen 40 mm (ca), Hindwing 32 mm. Differs but slightly from the male. Pterostigma yellow framed in black, rather longer than in the male, dilated. Body colouring more brightly metallic (probably not as adult as the male) and the yellow beneath abdomen broader and paler. The terminal segments of the abdomen missing.

Habitat: The female was said to have come from Port Denison but on the evidence now available, it appears certain that this was incorrect and that in all probability, the insect was collected in Victoria. The allotype male was collected by J. H. Courtenay at Yinnar, Victoria, 24. iv. 48; a single male now in the Dobson collection, Jersey. Type female, in the Museum Royal d'Histoire Naturelle, Brussels. *S. weyersi* differs from all other species by the broad juxtahumeral orange stripe, which is finely linear in other species or absent in *nigrescens*. The nipple-like tubercle behind the occiput also appears to be unique in the genus as I have not been able to find a similar structure in a large number of specimens I have examined belonging to other species. The superior anal appendages are devoid of spines other than the usual robust basal one and their structure is therefore simpler than in all others. In my paper in the *Bull. Musée Royal Belgique*, I gave *Lestes belladonna* Macleay as a synonym of *weyersi* but it now seems that this species must have been *tillyardi* from its northerly habitat. With all the known species now accurately placed it will be of value to give a fresh key for their easy determination.

Key to species of *Synlestes* Selys.

1. Superior anal appendages of the male greatly elongated and white in colour, deeply bifid, the outer branch nearly twice the length of the inner. Segment 10 of the female white .... *Episynlestes albicauda* Till.
Superior anal appendages of male not bifid; segment 10 of the female black .... 2.

2. Prothorax entirely yellowish, without any strongly contrasted black markings .... 3.
Prothorax largely bronzed black with strongly contrasted but restricted yellow markings .... 4.

3. Superior anal appendages of male with a large robust subapical spine on the inner side .... *Synlestes selysi* Tillyard.
Superior anal appendages of male without a large subapical spine .... *Synlestes tropicus* Tillyard.

4\. Superior anal appendages without a medial ventral process; juxtahumeral stripe of thorax very broad and orange coloured, complete except its upper portion .... *Synlestes weyersi* Selys.
Superior anal appendages of male with a process (spine or tubercle) on its ventral surface near the middle of appendage; juxtahumeral stripe of thorax finely linear and incomplete, pale yellow in colour .... 5.

5\. Pterostigma elongate, covering 4-5 cells; juxtahumeral stripe distinct; medioventral process a small tubercle .... *Synlestes tillyardi* Fraser.
Pterostigma short and stout, covering 3 cells; juxtahumeral stripe indistinct or obsolete .... *Synlestes nigrescens* Tillyard.

A new locality for *Zizeeria lysimon karsandra* Moore, 1865

By J. V. Peters.

The Dark Grass Blue, *Zizeeria lysimon karsandra* Moore has been recorded from the following localities: Townsville, Holbourne Is. (near Bowen), Mackay, Westwood, Brisbane and Milmerran in Queensland, Port Darwin and Groote Eylandt in the Northern Territory and Ballina, Richmond River, Wardell, Grafton, Bandon Grove and Bundanoon in the New South Wales (Dowling, 1961).

On 3rd September, 1961, I captured a single specimen of *Z. l. karsandra* on Quoin Island, some three miles from Gladstone, Queensland. The specimen is in my collection.

References.

Dowling, W. McK., 1961. Capture of *Zizeeria lysimon karsandra* Moore, 1865 at Bandon Grove, N.S.W. *Proc. R. Zool. Soc. N.S.W.* 1958-1959:110.

Waterhouse, G. A., 1932. What butterfly is that? Sydney.

Some New Locality Records of Butterflies

By E. O. Edwards

Zizeeria lysimon karsandra Moore, 1865.

The recorded distribution of this butterfly (Dark Grass-blue) is, according to Dr. G. A. Waterhouse, "Common from Brisbane to Townsville; also Port Darwin. I have caught it on the Richmond River and at Holbourne Island; J. Macqueen finds it commonly at Millmerran, Qld." The writer has taken it as far west as Mitchell, Qld., where it was common along the Maranoa River. It was therefore something of a surprise when my son, Ted Edwards, collected a specimen at Bundanoon on the Southern Tablelands of New South Wales (98 miles South of Sydney) on 27th March 1959. A careful check of the specimen revealed it to be true to type though duller above than the Millmerran specimen. In a letter Mr. L. Haines advises that a specimen was collected at Bandon Grove near Dungog, New South Wales (150 miles north of Sydney) by Mr. K. Dowling. It is possible that the range of this butterfly will be found to be much greater than previously recorded; it could be very easily mistaken in the field for one of the common blue butterflies.

Neolucia hobartensis hobartensis Miskin, 1890 (Mountain Blue).

On 31st December 1959 at Medlow Bath, on the Blue Mountains of New South Wales (about 3500 ft.), I collected specimens of this species previously recorded from high altitudes in Tasmania and at Mount Kosciusko in New South Wales. The butterflies were flying in an area where *Epacris* was in bloom. This is thought to be the foodplant of the larvae.

Life History of *Pseudalmenus chlorinda chloris* (Lepidoptera: Lycaenidae)

By E. Edwards and E. O. Edwards

On 10th January, 1959, in a gully near Katoomba (Blue Mountains, New South Wales) a search of a 6 ft. high plant of *Acacia elata* (Cedar Wattle) revealed a number of larvae attended by small black ants. From their appearance there was little doubt that these larvae were those of the butterfly *Pseudalmenus chlorinda chloris,* as they closely resembled those of the subspecies *fisheri* as illustrated and described by Tindale (1953). The attendant ants when disturbed stuck their tails in the air and when killed smelt strongly.

Another bush of Cedar Wattle, situated nearby, was almost denuded of its leaves but contained no larvae. A close search resulted in finding two pupae under a stone a few feet from the base of the plant. These pupae were brought home and kept in a cool place in a box in the dark with a small entrance into a cage. The first butterfly (a male) emerged on 30th August 1959 and the second (a female) emerged on 8th October 1959. This was surprising as it indicated that the butterflies would be on the wing for a greater period than had been previously recorded.

Two larvae brought home and fed on *A. elata* consumed large quantities of their foodplant, rate of consumption being far above the average local butterfly larva. This may have given the impression in the past that a large number of larvae were on the plant, whereas only three or four may denude a small bush. A visit to the same locality in November 1959 revealed numbers of the butterflies flying around the top of a tall Cedar Wattle. The tree contained many dead branches and it appeared as if the attendant ants were nesting in hollows in the dead branches. The tree was too tall and decayed for a safe investigation. The butterflies flew high around the top of the tree, too high to be caught. On this visit both eggs and young larvae were found on small bushes of the foodplant near the tall tree. At the beginning of December 1961 a visit was again made and larvae collected near the previous locality. Having cultivated a plant of *Acacia elata* it was possible to bring home a supply of larvae. These larvae had all pupated by the end of December. It was also noted that the larvae were eating galls on their foodplant.

Waterhouse (1932) refers to collecting "several pupae" but does not describe the larvae or eggs. It is doubtful if the life history of this subspecies has been recorded.

Ovum: very pale blue, mandarin shaped, heavily pitted. From two to five eggs laid together in the forks of the branches or near borer holes along the stems. None were found on the leaves.

Larva: Black, marked with dark chocolate and dark greenish brown lines and bands; a biscuit coloured stripe down the sides with a dark mauve stripe under the biscuit coloured stripe. Head black and concealed under the first segment. White stripes on each side of the first segment; two yellow oval markings on the third and eighth segments; two white marks like an inverted V on the last segment; white hairs on each segment; underneath pale green.

Pupa: Dull black and rough. Found under stones near the foodplant or in curled leaves or hollows made by borers and occupied by the attendant ants.

It has been found in captivity that the larvae do not seek hollow wood or curled leaves in which to pupate unless attended by their escorting ants.

A check on other localities similarly situated would be worth while, bearing in mind that the butterflies keep to the tops of tall specimens of their food plant. Specimens of the butterfly have been found at Blackheath during sleety weather (D. McAlpine, personal communication).

REFERENCES.

Tindale, N. B., 1953. New Rhopalocera and a list of species from the Grampian Mountains, Western Victoria. *Rec. S. Austr. Mus.* 11:43-68, pls. xviii-xxi, figs. 1-4.

Waterhouse, G. A., 1932, "What Butterfly is That?" Sydney.

Life History of the Butterfly *Hesperilla mastersi* (Master's Skipper)

By E. O. Edwards

In 1900 Dr. G. A. Waterhouse first named this butterfly, but for 60 years details of the life history remained unrecorded. In March 1960 Mr. T. H. Guthrie found the butterfly flying high around trees near Whale Beach, 25 miles north of Sydney. Varieties of Sword Grass *(Gahnia)* are frequently the foodplants of the larvae of the genus *Hesperilla* and this was suspected as being the foodplant of the larvae of this butterfly. Mr. Guthrie found that a Sword Grass *(Gahnia melanocarpum)* was growing in the vicinity, but exposed plants revealed no signs of larvae or pupae. A Hesperid egg however was found on the upper side of an old leaf near the base of a plant of *G. melanocarpum*, in deep shade among bushes. This proved to be the egg of *H. mastersi*. Subsequent investigation revealed that this species only breeds on plants growing in thick undergrowth, which possibly accounts for the difficulty of finding the larvae.

Up till 1933 less than 20 specimens were known from Gosford, Katoomba and Moruya in N.S.W. (Waterhouse, 1932). Since then specimens have been collected from Port Macquarie and Whale Beach in N.S.W. and Marracoota (Vic.) by Crosby (1951).

LIFE HISTORY.

(Taken from notes by Mr. Guthrie and larvae sent to me.)

Egg. Typically hesperid; hemispherical with about 24 radial ridges. Size: 1.2 mm. in diameter, 0.9 mm. high.

Larva. Quite distinctive, especially in the early stages, due to a half moon shaped mark on the rear segments and bright red on the first thoracic segment.

Newly hatched larva is long and cylindrical; very pale lemon yellow with the 1st thoracic segment bright red; no mid-dorsal line, but a lateral line of deeper lemon colour; a half moon shaped marking boarded with black on the anal segment with eight very long hairs protruding from the tail; the body is otherwise smooth. Head is dark shining brown with minute dimples and a depression at the centre of the dorsal apex (that is, behind the top of the head).

Full grown larva: Head brown-yellow or mid-brown marked with brown black. The two areas of colour rather sharply divided. Body, green-yellow with a lateral white stripe and two dorsal white stripes.

The segment behind the head is yellow and the anal segment orange. Beneath the larva is yellow.

The larvae live in shelters made by drawing the leaves of the food-plant together.

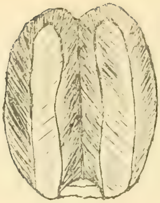
Pupa: Dark brown with a distinctive pupal cap of shining dark brown with low raised, somewhat rounded, area of black, but not high level platforms like pupal caps of *H. donnysa*. They pupate in the shelter made by the larva.

As the books in which a description of this butterfly is given have been out of print for many years, a brief description of the butterfly is given. Male above: forewing, brown-black suffused with orange brown; large cell spot; 3 subapical spots; discal spot in area 3 all pale orange hyaline; narrow discal sex mark from dorsum to vein 4, black, broad central orange band.

Beneath: forewing red-brown; spots as above; extra pale orange hyaline spots in area 1a and 2; series of cream apical spots.

Female similar to male but spots in forewing larger and wings more convex.

1



2

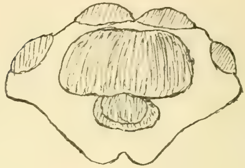


Fig. 1. Larval head of *H. mastersi.* Dark shaded portion very dark brown. Lightly shaded portion mid-brown.

Fig. 2. Pupal cap of *H. mastersi.* Shaded portion dark shining black with a few dark hairs. Plain portion dark shining brown and relatively smooth.

REFERENCES

Waterhouse, G. A., 1932. "What Butterfly is That?" Sydney.

Crosby, D. F., 1951. Notes on some Eastern Victorian Butterflies with a new Victorian Record. *Vic. Nat.* 68: 97-101.

The Birds of Canada Bay, N.S.W.

By L. Courtney Haines.

Plates II-VII.

The various swamps and marshes fringing the tidal bays and backwaters of the Parramatta River attract numerous species of birds, and in particular those whose diet consists of insects and marine animals.

One of the most easily accessible of swamps is the mangrove marsh occurring at the head of Canada Bay, which in turn lies at the extreme end of Hen and Chicken Bay.

When the tide is out, extensive mud-flats adjoining the mangroves are exposed and become the feeding grounds of many wading birds; but at the turn of the tide the exposed banks gradually decrease in area, forcing the feasting birds to seek refuge. Large wading birds such as herons and egrets move to the mangrove trees or perch upon old stumps protruding from the water, while the smaller wading forms fly to the salt-pans, there to await, almost hidden from view amongst the succulent salt bushes, for the tide to ebb, when once again their feeding grounds are accessible.

The swamp itself consists of several acres of mangroves, thinning out into *Salicornia* covered salt-pans. In close proximity are playing fields possessing a few she oaks *(Casuarina* sp.) and box brushes *(Tristania* sp.). Swamp margins, overgrown with rank grasses, sedge and reeds, form ideal breeding haunts for Golden-headed Fantail-warblers *(Cisticola exilis).*

Although the Concord side of the swamp is bordered by an unattractive concrete storm-water channel, the Five Dock margin happily supports a number of coral and gum trees, together with thickets of lantana, blackberry, bramble and blackthorn bushes, the latter forming satisfactory cover for several species of passerine birds, amongst which Silvereyes *(Zosterops lateralis)* and Blue Wrens *(Malurus cyaneus)* predominate.

If one follows the Five Dock margin for some little distance, a second storm-water channel is encountered, and immediately adjoining is a reclaimed area, top-dressed with black ash material. This forms the main breeding-ground of the Red-capped Dotterel *(Charadrius alexandrinus ruficappilus)* and the Black-fronted Dotterel *(C. melanops).*

Until recently, two fresh-water ponds, overgrown with bullrushes, lillies and other aquatic vegetation, were to be found at the end of this reclaimed area. Here amidst the whispering of the rushes, the sad but musical piping of Little Grassbirds *(Megalurus gramineus)* would harmonise with the loud joyous song of numerous Reedwarblers *(Acrocephalus australis).* Also in these lush surroundings the cradle-like nests of Dusky Moorhens *(Gallinula tenebrosa)* could be found; but the ponds, delightful though they were to both birds and bird watcher, were not allowed to remain, and have completely disappeared.

Canada Bay swamp has been used as a banding station by members of the Australian Bird-banding Scheme, C.S.I.R.O. With the aid of "mist" nets, and working in the early hours of the morning, banders have already snared and ringed Curlew Sandpipers *(Calidris ferruginea),* Sharp-tailed Stints *(Calidris acuminata)* and Golden Plovers *(Pluvialis dominica).*

During the past eight years and on odd occasions prior to 1954, I have been interested in listing and studying the bird species frequenting and visiting this area. Altogether 73 species have been observed; of these 14 are breeding species, and at least 7 of the migratory waders are regular annual visitors. The remainder have been generally observed. Some, such as the White-headed Stilt *(Himantopus himantopus),* Banded Plover *(Zonifer tricolor)* and Brown Songlark *(Cinclorhamphus cruralis),* being regarded as great rarities, as far as Canada Bay is concerned.

The arrangement of species in the following list is according to that used by Messrs. K. A. Hindwood and A. R. McGill, in their book, "The Birds of Sydney," 1958.

Map showing location of Canada Bay.

ANNOTATED LIST.

1. Brown Quail *Corturnix australis.* Two records. A bird was seen walking along the sloping wall of the storm water channel on Oct. 9, 1954, and another bird was flushed from cover on Oct. 19, 1957.
2. King Quail *Corturnix chinensis.* A nest, presumably of this species, constructed in a rusty jam tin was found during Nov. 1942. The nest contained an egg, the remains of another egg, and a dead featherless young bird. *(Emu* 42: 252).
3. Dusky Moorhen *Gallinula tenebrosa.* The peculiar call of this bird is sometimes discernible in the mangroves. Nest cradles have been located, usually placed about a foot above water level in the rushes growing in the fresh water ponds. During summer and autumn months young moorhens have been observed.
4. Little Grebe *Podiceps novaehollandiae.* Usually present in small numbers during autumn and winter months.
5. Hoary-headed Grebe *Podiceps poliocephalus.* Autumn and winter visitor. More numerous farther downstream at Iron Cove, where scrags of two hundred or more congregate.
6. Black Cormorant *Phalacrocorax carbo.* Sometimes observed fishing in the bay. It is not unusual to see these birds break the surface of the water after a long dive with an eel writhing in their bill.
7. Little Black Cormorant *Phalacrocorax sulcirostris.* Regularly observed, but more common during winter and spring months of 1957. This species fishes the shallows in large packs.
8. Little Pied Cormorant *Phalacrocorax melanoleucus.* Numbers always found inhabiting the outskirts of the mangroves, where they perch with outspread wings, drying off their plumage. This little cormorant differs considerably from the preceding species in its habits of feeding, preferring to fish singly, odd birds being distributed over a large expanse of water. Sometimes birds are noticed with a chestnut colour staining their white breast and neck plumage. *(Emu* 45: 152).
9. Little Tern *Sterna albifrons.* Nearly always to be observed fishing in the bay during the warmer months of the year.
10. Crested Tern *Sterna bergii.* Occasionally observed.
11. Silver Gull *Larus novaehollandiae.* Common species frequenting the foreshores. When stormy weather prevails, hundreds of birds are to be seen inhabiting adjoining playing fields.
12. Spur-winged plover *Lobibyx novaehollandiae.* Several always to be found feeding, either on the mud-banks adjoining the mangroves, or amongst the salt-pans, depending upon tidal conditions.
13. Banded Plover *Zonifer tricolor.* A lone bird observed on Sept. 8, 1957.
14. Golden Plover *Pluvialis dominica.* Arrives in early Sept. when numbers are still in beautiful nuptial plumage but this soon disappears and is replaced by the mottled brown, buff and white eclipse dress. As a rule the flock inhabits the salt pans, where they are almost concealed from view by the colourful *Salicornia.* Golden Plover remain in the swamp until April, when they migrate north to their breeding haunts in North-eastern Siberia. During the month prior to departure many birds are seen in splendid black, white and golden breeding attire. Other places favoured by this species, are the muddy foreshores of the bay at low tide, and rock strewn areas. The birds are cryptically hidden from view in the latter places.
15. Mongolian Dotterel *Charadrius mongolus.* Uncommon species. One bird observed on Oct. 4, 1954. Two birds recorded, feeding along the margin of the bay on Feb. 19, 1955, whilst eight birds were seen in the swamp on Dec. 30, 1956.
16. Red-capped Dotterel *Charadrius alexandrinus.* A number of nests have been found. It is interesting to note that eggs deposited on the black-ash strewn area are of the dark fawn ground colour type. These are heavily marked with large patches of dark brown, mainly clustering at the larger end, and generally quite different in appearance to eggs located on white shingle and sandy places. The latter form having a creamy-white ground colour, marked all over with small blotches of brown and underlying markings of lavender. Most nest depressions are lined with the usual shell chips and pebbles, but nests have also been located in which the lining is composed of short pieces of grass. This species swims

quite well, and I have observed flightless, downy young, when being pursued, race into the water and swim away to safety. I have also seen a shot adult female, unable to fly because of an injured wing, escape temporary capture by plunging into the bay, and swim most buoyantly into mid-stream. Red-capped Dotterels congregate about the salt pans in large numbers during winter months. *(Proc. R. Zool. Soc. N.S.W.* 1958-59: 48).

17. Black-fronted Dotterel *Charadrius melanops.* Regular inhabitants. Flightless young often observed during summer months. A depression containing two slightly incubated eggs was found on Oct. 20, 1956. This nest was lined with small bones, and nearby was a rodent's skull, presumably that of the Common Rat, *Mus rattus.* Another nest located on Sept. 15, 1957, contained the usual clutch of three, and was lined with lengths of grass.

18. Eastern Curlew *Nemenius madagascariensis.* Usually a solitary bird is to be seen feeding at low tide about the mangroves fringing the bay. On Dec. 26, 1955, two curlews glided into the salt-pan area, putting down within a few feet of a grassy bank, behind which I was concealed. It was one of those golden afternoons and the rays of the setting sun enhanced the rich tints of their plumage considerably, showing to advantage what a fine big wader the Eastern Curlew really is, when viewed under such ideal conditions.

19. Bar-tailed Godwit *Limosa lapponica.* The summer of 1954-55 was remarkable for the large number of godwits frequenting the marshy backwaters of the Parramatta River.

20. Grey-tailed Tattler *Heteroscelus brevipes.* One bird recorded inhabiting the salt-pans during the 6th and 9th Jan. 1957.

21. Curlew Sandpiper *Calidris ferruginea.* An occasional visitor. This quiet grey bird can easily be distinguished from the Sharp-tailed Sandpiper, by its decurved bill and white tail covets shown in flight.

22. Sharp-tailed Sandpiper *Calidris acuminata.* Arrives in early August, departing late March. Sometimes arrivals have good traces of their northern latitude breeding dress. This reddish tint is also apparent again during the period preceding their departure in autumn. Sharp-tailed Sandpipers are usually found inhabiting the salt-pans and the banks of the creek which wends its way through the mangroves. The summer of 1954-55 was outstanding for the large numbers present.

23. Red-necked Stint *Calidris ruficollis.* An early spring arrival, when odd birds are to be observed with remnants of their reddish breeding plumage. This colour soon moults out, and is replaced by a no less attractive colour combination of soft greys. Stints feed mainly in the company of Red-capped Dotterels, which they match in size, but can be easily picked out even from a distance by their more active method of feeding.

24. Japanese Snipe *Gallinago hardwickii.* Three birds put up from marshy grassland at the extreme end of the swamp on Oct. 4, 1954.

25. White-headed Stilt *Himantopus himantopus.* Several birds answering to the description of this species were observed by the late Donald Montgomery, during Dec. 1939. It is of interest to mention at this point, that a single example of this plover, now days rarely seen in the metropolitan area, was recorded by the author farther down the river at Iron Cove, two years earlier in Dec. 1937. *(Proc. R. Zool Soc. N.S.W.* 1958-59: 50).

26. White Ibis *Threskiornis molucca.* Occasional visitor.

27. White-necked Heron *Notophoyx pacifica.* One record of a single bird feeding about the fringes of the fresh-water ponds in Jan. 1956.

28. White-faced Heron *Notophoyx novaehollandiae.* Common, seen at all times. Large numbers feed on the exposed mud-banks, whilst solitary birds are frequently found fishing the shallows.

29. White Egret *Egretta alba.* Usually found feeding in the shallows, or perched on mangrove stumps.

30. Nankeen Night-Heron *Nycticorax caledonicus.* This nocturnal species arrives at the swamp during dusk; usually one adult bird in the company of several stripy plumaged immature birds. They are mainly found feeding on the mud-banks exposed by the receeding tide.

31. Mangrove Heron *Butorides striata.* At one time fairly common, but now days rare in the swamp. Sometimes a single bird is seen at dusk, skulking about the outskirts of the mangroves adjoining the bay.

32. Black Swan *Cygnus atratus.* One observation only, Sept. 8, 1957.

33. Black Duck. *Anas superciliosa.* Occasionally observed.

34. Chestnut-breasted Teal *Anas castanea.* One male recorded on Aug; 12, 1957. Earlier in the year, April, 20, at Homebush Bay farther up stream, twenty-six males of this beautiful teal were observed.

35. Grey Teal *Anas gibberifrons.* Often encountered, feeding in the shallows near the mangroves. The autumn and winter of 1957 was extraordinary for the large numbers of teal inhabiting the backwaters of the Parramatta River. The vast majority were concentrated farther up the river at Homebush Bay, where a count of 600 was made on April, 20.

36. Musk Duck *Biziura lobata.* A number present during autumn and winter of 1957. As a rule this duck keeps well out in the bay.

37. White-breasted Sea-eagle *Haliaetus leucogaster.* This fine species is sometimes to be seen floating high above the course of the river.

38. Black-shouldered Kite *Elanus notatus.* First observed hovering over the salt-pans on Jan. 19, 1958. A nest containing young the following year, July 30, 1959. These nestlings were banded, one of which was later found dead at Waterfall, approximately 20 miles south of Sydney. (Band No. 110-27503).

39. Little Falcon *Falco longipennis.* One observation only. During the afternoon of Feb. 12, 1956 whilst wandering around the margin of the swamp, I noticed a number of Red-capped Dotterels, (*Charadrius alexandrinus*) standing very still. As I drew nearer to them, they moved their legs up and down in a jerky manner, but refused to run or fly away from me. Every now and then they would twist their necks, so as to gaze upwards into the sky. Obviously they were aware of something of which they were afraid. This proved to be the case, for very soon a Little Falcon swept low across the swamp. The Dotterels, however remained stationary for several minutes before flying out into the salt-pans.

40. Nankeen Kestrel *Falco cenchroides.* Sometimes seen hovering over the fields and rank grassland.

41. Sacred Kingfisher *Halcyon sancta.* Two birds, presumably a pair, camped in the fringes of the mangroves during the winter months of 1955 and 1956.

42. Horsfield Bronze Cuckoo *Chalcites basalis.* An immature bird observed on May 26, 1956.

43. Welcome Swallow *Hirundo neoxena.* Very common during spring and summer. A few birds remain about the swamp throughout the winter.

44. Fairy Martin *Hylochelidon ariel.* A single bird recorded flying about the salt-pan area in company of Welcome Swallows on Nov. 13, 1954. Another record of a single bird was made on Dec. 11, 1958.

45. Grey Fantail *Rhipidura fuliginosa.* A solitary bird observed in the mangroves by Major S. G. Lane on Sept. 23, 1956.

46. Black and White Fantail *Rhipidura leucophrys.* A common species frequenting the outskirts of the mangroves and surrounding areas. It is interesting to note that during the winter the call seems to be restricted to the curious chattering used when the birds are nesting, presumably as a warning to intruders. This call is uttered mainly at dusk when birds are enjoying a last minute forage about the rocks fringing the foreshores; and because of its harshness, blends very well with the bleak surroundings. An interesting contrast is the sweet nocturnal song of spring when fantails seem to sing the words, "sweet pretty creature," some birds having clearer "diction" than others. Fantails appear to be in excellent plumage in late autumn, the white markings about the face being most noticeable, and especially so if the birds are excited, when they are shown to advantage.

47. Restless Flycatcher *Seisura inquieta.* One female observed feeding in a Coral Tree on June 11, 1955.

48. Brown Flycatcher *Microeca fascinans.* The jerky song of this little flycatcher may be heard continually during the sunny mornings of early spring.

49. Rose Robin *Petroica rosea.* A female of this species was observed frequenting the mangrove on July 30, 1960.

50. White-fronted Chat *Epthianura albifrons.* At one time common, nowadays becoming rare.

51. Brown Song Lark *Cinclorhamphus cruralis.* This rare visitor, a male, was observed on 19 and 20 Oct., 1957.

52. Little Grassbird *Megulurus gramineus.* Reasonably common, both in the mangroves and the rushes. Nests discovered in the swamp were built of mangrove tendrils, and lined with the usual feathers. One nest contained feathers of the Silver Gull, *Larus novaehollandiae,* and was placed eight feet up in a sapling. Another nest was found five feet above mud surface, in outer twigs. The fresh water ponds contained well concealed nests built amidst the rushes. All nests were three to four feet above water-level and were constructed of dried rush fronds. The dismal wailing call notes of this little warbler are to be heard at most times of the day, and possess a peculiar minor key tone, even although only one degree of a scale is piped in its song. Calculations of the singing pitch were made, and birds were discovered performing on notes E natural, F sharp, G natural, octave F sharp, and octave A respectively above middle C. A curious chattering call is produced when the species is feeding, and especially when chivvying their young. Immature birds have been observed in the mangroves and, like the adults, they run and skip across the surface of the mud with great agility.

53. Reed Warbler *Acrocephalus australis.* Numerous nests have been found in the rushes growing in the freshwater ponds. Nests were constructed usually from 2½ feet to 4 feet above water surface, and the depth of the water beneath the nests was approximately 4 feet. Rarely were nests located built on the fringes of the rush beds! All nests were constructed of dried rush fronds. The several sets of eggs examined were of the greyish-white ground colour type, and at no time were *atypical* eggs discovered in clutches. The complete clutch was always three in number. The Reed Warbler has never been observed in the mangroves; sometimes, the loud song of the Brown Honeyeater, *Lichmera indistincta,* has been mistaken for that of the Reed Warbler, there being a decided resemblance in the two species' call notes.

54. Golden-headed Fantail-warbler *Cisticola exilis.* Several pairs always found inhabiting the rank grassland. Throughout the months of winter the male of this species possesses, like the female, a striped crown and a long tail; but with the approach of the nesting season cock birds may be easily distinguished from the hens by gradually assuming a golden crown. A short tail is also adopted during the nesting season by both sexes. This charming warbler, in size no larger than a robust grasshopper, is one of the most interesting of birds. It constructs a wonderful nest, around which the leaves of living plants are often carefully sewn, and because of this, the species is also appropriately referred to as the Tailor Bird. Clutch sizes vary from 2 to 4, and on rare occasions nests containing a complement of 5 are found. The eggs are blue in colour, adorned mainly on the larger end with brown and blackish-brown irregular-shaped spots. The young are to be observed on the wing at the end of summer and early autumn, their lemon-shaded breast feathering immediately distininguishing them from the adults.

55. Blue Wren *Malurus cyaneus.* The explosive warble of this little bird is remarkably loud when listened to in the mangroves. This is presumably due to the acoustics of the stillness and cloistered atmosphere of a mangrove forest. A nest located contained three eggs and was built two feet above the ground in a lantana bush growing near the edge of the swamp.

56. Black-faced Cuckoo-shrike *Coracina novaehollandiae.* Nearly always present, or observed passing over the swamp.

57. Grey-breasted Silver-eye *Zosterops lateralis.* Common species in the mangroves, also frequents the Coral Trees and the lantana thickets.

58. Brown Honeyeater *Lichmera indistincta.* During early spring, the beautiful cup-shaped nests of this unobtrusively coloured honeyeater are to be found in the mangroves, and probably rival for smallness of size nests of the Black and Scarlet Honeyeaters *(Myzomela nigra* and *M. sanguinolenta),* two species con-

sidered to build the smallest nests in Australia, as far as the *Meliphagidae* are concerned. The eggs of the Brown-Honeyeater are white, and very sparingly marked on the larger end with dark brown spots; a clutch of two is the usual complement. Various positions are selected in which to build, but as a rule no higher than three feet above the surface of the mud. A nest found in a small mangrove growing on the fringes of the swamp was placed well out of sight, it being necessary to push aside the leaves so as to reveal the nest and its contents. Other nests, however, have been located in the interior of the mangroves attached to thin twigs and in exposed positions, being easily seen from a distance of twenty feet or more. During winter months this little honeyeater is found feeding in the flowering Coral Trees, where its presence is soon made known by its loud and beautiful singing.

59. Pipit *Anthus australis.* Several pairs nearly always to be found feeding about the borders of the salt-pans, or in the coarse grass bordering the water channel. On Oct. 17, 1957, a nearly fully fledged young was observed, and two days later, a nest constructed in a rusty paint tin lying on its side amidst the *Salicornia* was found. This unusual nest contained three well grown young.

60. Raven *Corvus coronoides.* Sometimes present in the mangroves, but usually observed flying over the swamp, towards Homebush Bay, where they congregate in large numbers.

61. Magpie-lark *Grallina cyanoleuca.* Frequents the storm-water channel when the tide is out. At high tide, feeds about the fringes of the salt-pan or adjoining fields.

62. Black-backed Magpie *Gymnorhina tibicen.* Breeds in the She Oaks growing at the extreme end of the swamp. Nests have been observed in top most branches. forty feet from the ground.

INTRODUCED SPECIES.

63. Rock Dove (Domesticated Pigeon) *Columbia livia.* Usually frequents the salt-pans and rocks bordering the bay.

64. Spotted Turtle-dove *Streptopelia chinensis.* Common in the mangroves, where many nests are found built of mangrove twigs. Nests are usually placed three to five feet above the mud surface.

65. Red-whiskered Bulbul *Pycnonotus jocosus.* Another common species found inhabiting the mangroves and also the thickets growing round the foreshores of the bay.

66. Skylark *Alauda arvensis.* One of the pleasures of a spring morning is to listen to this introduced species' glorious song.

67. Common Starling *Sturnus vulgaris.* During late afternoon it is an interesting sight to watch huge flocks fly about the swamp before settling down in the mangroves for the night.

68. Common Myna *Acridotheres tristis.* This species appears to be more common than it used to be in the swamp area. Mynas inhabit mainly the playing fields and salt-pans.

69. Goldfinch *Carduelis carduelis.* Nests as a rule in the top-most branches of the taller mangroves. Those discovered have been constructed of wool gathered from nearby rubbish dumps. One nest examined contained red, yellow, orange and blue knitting wool worked into it, the egg-cup being lined with white and yellow thistle-down, making it nearly as colourful as its owner.

70. House Sparrow *Passer domesticus.* Common species.

71. Spice Finch *Lonchura punctulata.* Two birds identified as this species were observed at close range on March 24, 1956. The species was again seen on Oct. 11, 1958, when approximately eleven were put up from rank grass.

ACKNOWLEDGMENTS.

Through the courtesy of Messrs. K. A. Hindwood and A. R. McGill, permission was kindly granted to use the illustration of the Reedwarbler, which appears in their book, "The Birds of Sydney."

Sincere thanks are also due to Messrs. N. Chaffer and K. A. Hindwood for the excellent studies of the Little Grassbird, Brown Honeyeater, Golden-headed Fantail-warbler, and views of Canada Bay.

Observations on Some Australian Forest Insects

10. An Indigenous Insect, *Panacela lewinae* (Lewin) (Lepidoptera: Eupterotidae) Attacking Exotic *Pinus* spp. in New South Wales

By K. M. Moore.
(Forestry Commission of New South Wales.)

Plate I.

SUMMARY

Attack by *Panacela lewinae* (Lewin) (Lewin's bag-moth) occurred during 1960 on State Forest plantations of *Pinus* spp.

Results of investigations into the biology, distribution, hosts and previous records of this insect are given and the various stages are described and figured. Damage to *Pinus* spp. and broad-leaved tree species is described.

Coloration of adult males bred from a single colony, is variable.

INTRODUCTION.

A threat of extensive damage to exotic pine plantations in Australia through the introduction of insect pests which have damaged pine forests in England, Europe, Canada and the U.S.A. is recognised, but some indigenous insects which have transferred their feeding habits from the natural flora to *Pinus* spp. in New South Wales may also become of economic importance to forestry.

Approximately 80,000 acres of *Pinus* spp. have been planted by the Forestry Commission in N.S.W. and investigations into the incidence of insect attack on these plantations are being made. During the first year, several insects, some of which appear to be of potential economic importance, were found to be attacking *Pinus* spp. and causing varying amounts of damage.

Because of the extent of damage by *Panacela lewinae* (Lewin) on Mount Topper State Forest during 1960, an examination of the biology of this insect was made.

PREVIOUS REFERENCES TO *Panacela lewinae.*

This species has been referred to by numerous writers under the following names:—

Bombyx lewinae Lewin (1805); *Thaumetopoea lewinii* Schaeffer (1853); *Pamea transiens* Walker (1855); *Oreta sobria* Walker (1855); *Eriogaster ? simplex* Walk. (1855); *Naprepa pilosa* Walk. (1865); *N. hirta* Walk. (1865); *Panacela rufescens* Walk. (1865); *Semuta pristina* Walk. (1865); Turner (1902) gives *Clisiocampa lewinae, Trilocha rufescens* and *Semuta prisca* as synonyms of *Ocinara lewinae,* then refers to the species (1922) as *Panacela lewinae;* Froggatt (1923) published some of the insect's biology together with three figures, under the latter name and with the common name of Lewin's processional caterpillar moth; Strand (in Seitz 1929) and Anonymous (C.S.I.R.O., 1955) refer to the species as *Lewinibombyx lewinae* (Lew.); specimens in the collection of the Forestry Commission have been identified at The British Museum, London, as *Triloba simplex* Walk., and by I. F. B. Common of C.S.I.R.O. as *Panacela lewinae.*

The latter name is used in this paper.

HOSTS.

The following species are known to be hosts of *P. lewinae*:—*Eucalyptus triantha* Link (white mahogany); *E. deanei* Maiden (Deane's gum); *E. gummifera* (Gaertn.) Hochr. (bloodwood); *E. lindleyana* DC. (kayer-ro or river peppermint); either *E. tinghaensis* Blakely & McKie (Tingha stringybark) or *E. McKieana* Blakely (McKie's stringybark); *E. umbra* R. T. Baker (bastard mahogany); *E. paniculata* Smith (grey ironbark); *E. propinqua* Deane & Maiden (small-fruited grey gum); *E. piperita* Smith (Sydney peppermint); *Angophora floribunda* (Sm.) Sweet (rough-barked apple); *Acacia filicifolia* Cheel et Welch; *A. prominens* A. Cunn. ex G. Don. (Gosford wattle); *Syncarpia glomulifera* (Sm.) Niedenzu (turpentine); *Exocarpus cupressiformis* Labill. (native cherry) (a root-parasite of *Eucalyptus* spp.); *Pinus radiata* D. Don. (Monterey pine) and *P. patula* Schlect. & Chamisso (spreading-leaved pine).

A number of larvae collected from *E. deanei* were reared to adults in the laboratory on *Eucalyptus saligna* Smith (Sydney blue gum), and those occurring on *E. triantha, A. floribunda, S. glomulifera* and *P. radiata* were reared on their respective host-plants.

Larvae could not survive on *Callitris rhomboidea* R. Br. (Port Jackson cypress pine) or *C. hugelii* (Carr.) (white cypress), and although a group of eggs was laid on the former species in the field, larvae shrivelled during the first instar. Larvae on *S. glomulifera* and *E. triantha* in the immediate vicinity developed normally.

During 1953 to 1955 severe attack and consequent defoliation by a closely allied species of *Panacela* had occurred on *E. gummifera* and *Tristania conferta* R. Br. (brush box) on Bald Knob State Forest, Yabbra S.F. and Donaldson S.F. (Casino Forestry District: Urbenville Subdistrict), but no records of attack by *Panacela* spp. on *Pinus* spp. could be found.

DISTRIBUTION.

P. lewinae occurs from sea-level to an altitude of about 3,500 feet and has been collected in New South Wales from Gibraltar Range S.F. and Mount Topper S.F. (Glen Innes Forestry District: Inverell Subdistrict); Tuggolo S.F. (Tamworth Subdistrict); Ourimbah S.F. (Newcastle District: Wyong Subdistrict); Cumberland S.F. (Metropolitan Forestry District); Macquarie Pass in the Illawarra district, Uralla on the Northern Tablelands and from Lisarow on the Central Coast. Froggatt (1923) reported attack occurring as far south as Bateman's Bay and Bega on the coast during 1903 and heavy attack in the Gilgai-Bundarra area on the North-West Slopes during 1911. Turner (1902) records the species occurring at Brisbane, Queensland; Walker (1865) states that a specimen in the British Museum is from Swan River (presumably from Western Australia), and there are specimens from Cronulla, Manly and Port Macquarie, N.S.W., in the Australian Museum.

DAMAGE.

When feeding on broad-leaved host-plants such as *Angophora* spp. and *Eucalyptus* spp., early instar larvae skeletonise foliage, but during later instars the leaves are consumed by them. On *Pinus* spp., larvae feed either at the distal ends of the needles, or cut through them near the proximal end so that the distal portions are detached and fall to the ground. Maximum damage to foliage occurs during November and December when most larvae are in the last instar. Trees of all ages are attacked.

Large trees of *P. radiata* and *P. patula* on Mount Topper S.F., Mt. Mitchell S.F. and Armidale S.F. which were inspected during December 1960 were not severely damaged although the shelters of larvae were numerous and widely distributed on foliage throughout the 570 acres of *Pinus* spp. on Mt. Topper S.F. Young trees of *P. radiata* up to 10 feet in height and large trees of *A. floribunda* were defoliated (Pl. 1, fig. 1).

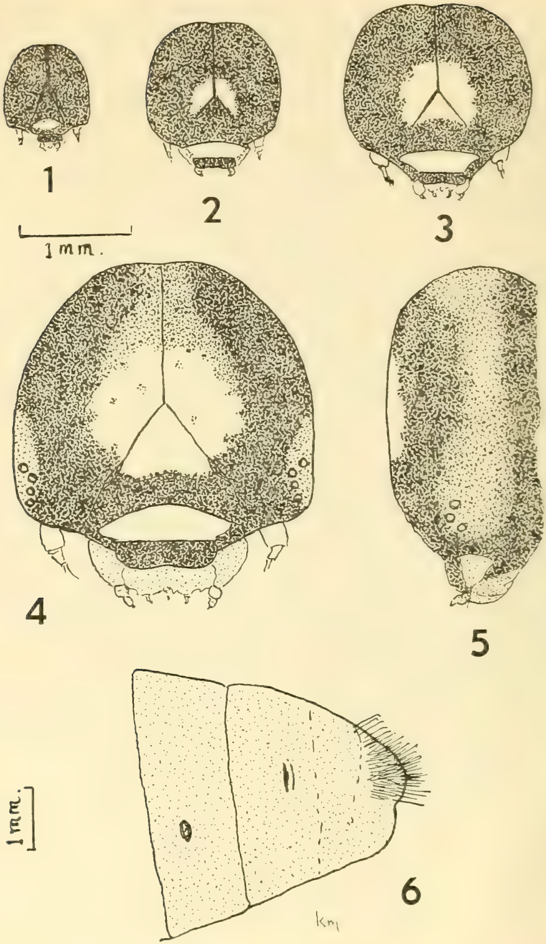
BIOLOGY.

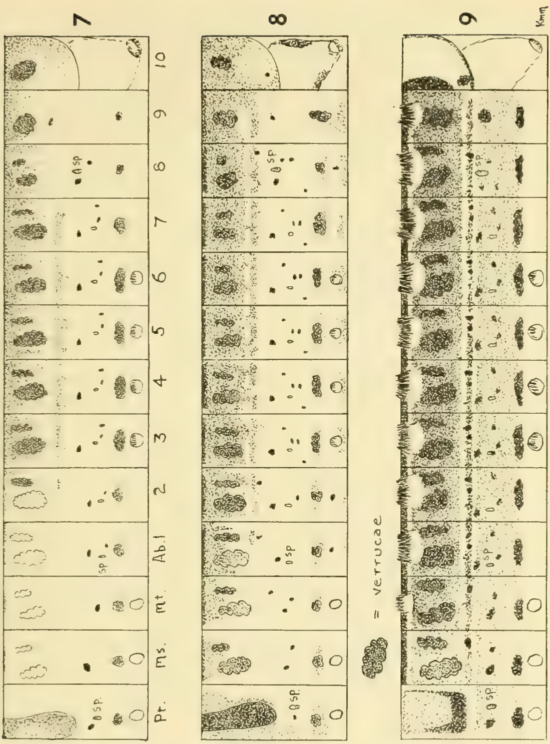
Eggs are approximately 0.7 mm. in diameter, opalescent, smooth, more or less spherical and with the base concave. They occur usually in compact groups of up to 300, the groups often being completely covered by setae from the distal portion of the female moth's abdomen. Eggs may be found during January to May occurring on all aspects of, and at all heights on, the host-plant, and hatch during March to May.

Larvae.

Larvae pass through six instars, and during each succeeding instar bear an increased number of barbed setae and groups of smooth short spines which may cause severe irritation to the skin when contacted.

Layers of silk which bind several leaves together are constructed by first instar larvae (Pl. 1, fig. 2). Leaves of broad-leaved species incorporated in the silken layers are skeletonised by larvae feeding within the shelter where a considerable quantity of excreta may be retained. Shelters are sometimes constructed around the bole of a host-tree at ground-level instead of on the foliage, and then appear similar to those of *Ochrogaster contraria* (Walk.) (the bag shelter or processionary caterpillar).


1
2
3
1 mm.
4
5
1 mm.
6
km



EXPLANATION OF TEXT-FIGURES.

Panacela lewinae from *E. triantha*, Lisarow.

Fig. 1. Head-capsule of second instar larva.
Fig. 2. Head-capsule of third instar larva.
Fig. 3. Head-capsule of fourth instar larva.
Fig. 4. Head-capsule of sixth instar larva (anterior).
Fig. 5. Head-capsule of sixth instar larva (lateral).
Fig. 6. Posterior segments of pupa, showing cremaster.
Fig. 7. Map of first instar larva.
Fig. 8. Map of second instar larva.
Fig. 9. Map of sixth instar larva.

During the third and subsequent instars, a single group of larvae may disperse into several smaller groups and construct separate shelters on other portions of the foliage. Additional external layers of silk webbing may be constructed on the original shelter, thus enlarging the bag.

About 350 larvae of the third and fourth instar may occur in one bag. Larvae remain in the shelters during the day, usually emerging during the night when they disperse over the foliage to feed. After feeding for three or four consecutive nights larvae may remain in the bags without further feeding for several days. The boles, branches and twigs of some host-plants appear silvery-grey when covered with the silken strands constructed by larvae as they proceed to the feeding-sites.

When ecdysis occurs either within the shelters or on their outer surfaces, exuviae may remain attached to the shelters for many months. During the day larvae often cause a loud scratching or rustling noise by twitching the head and thorax and the anterior portion of the abdomen, from side to side. The noise is apparently caused by the rubbing of the mandibles or the thoracic legs against the silken threads, and is amplified by the dried foliage incorporated in the silken bag. When larvae are disturbed, they twist and turn vigorously, often falling to the ground, or descending on silken threads.

Larvae at Mount Topper S.F. during December 1960 were observed to have dispersed over the foliage of either the attacked trees or those nearby, or through the grass below these trees.

Maps showing verrucae and the more usual pattern of the dark areas on larvae during instars 1, 2 and 6 on *E. triantha* at Lisarow, are given in figs. 7 to 9. Because of the large number of barbed setae and spines on larvae of each instar, their locations are not indicated on the maps.

A last instar larva is figured in colour by Lewin (1805).

Descriptions. (Larvae from *E. triantha*, Lisarow).

The coloration of larvae from various localities, or from the same colony, varies considerably.

1st instar. Approximate length up to 5 mm. Head capsule: dark brown to black, and white absent from epicranium and frons. General coloration: cream and brown; prothorax with a variable, transverse brown area; meso- and metathorax and abdominal segments 1 & 2 pale fawn; remainder of abdominal segments dorsally, progressively darker brown posteriorly; segment 10 brown.

2nd Instar. Length, ca. 5 mm. to 8 mm. Head capsule black (fig. 1). General coloration: similar to 1st instar, but dorsal brown area more extensive and darker; groups of spines and a few barbed setae arising from red-brown verrucae, with barbed setae longest on meso-thorax and abdominal segment 10; spines and setae more numerous than 1st instar.

3rd instar. Length, ca. 8 mm. to 10 mm. Head capsule with white crescent on epicranium adjacent to apex of frons (fig. 2). General coloration: similar to 2nd instar, but brown areas darker and more extensive.

4th instar. Length, ca. 10 mm. to 13 mm. Head capsule with a white circle extending across upper half of frons, and an indistinct cream area contiguous to ocelli; remainder dark brown but paler along median suture of epicranium (fig. 3). General coloration: similar to 3rd instar, but darker and suffused with pink; dorsal verrucae now cream; a prominent medio-dorsal longitudinal stripe dark brown to black; a narrow medio-ventral dark stripe on abdominal segs. 1 to 9; ventro-lateral verrucae darker and more elongate longitudinally than in previous instars.

5th instar. Length, ca. 13 mm. to 20 mm. Head capsule and clypeus as in 4th instar, but white area near ocelli more extensive. General coloration: paler than 4th instar; dorsal area diffused tan, and with median stripe indistinct; posterior pair of dorsal verrucae and anterior pair on dorsal edge, brown, on each segment; groups of dorsal spines on each abdominal segment overlapping medio-dorsally; sometimes a narrow white dorso-lateral stripe above the spiracles, and two narrow white medio-dorsal stripes; abdominal segment 10 white posteriorly; dark medio-ventral stripe absent.

6th instar. Length, ca. 20 mm. to 28 mm. Head capsule with white circle as in instars 4 and 5; white area contiguous to ocelli extending to epicranial

suture (figs. 4 & 5). General coloration: green, mottled brown and orange-brown; both barbed setae and spines very numerous; a large dense oval tuft of black spines with bases cream, at centre of each abdominal segment medio-dorsally, and a smaller tuft on meta-thorax; each group of spines is joined by two thin white lines which continue on to the meso-and meta-thoracic segments; two thin white lines above the spiracles each side; posterior of abdominal segment 10 mainly white; barbed setae darker than in 5th instar.

Pupae.

Larvae usually leave the bag shelters to pupate among the foliage, under bark or among leaves and debris near the base of the host-plant. They construct thin-walled cocoons of pale brown silk in which their setae are incorporated. Pupation occupies about five weeks. Pupae are at first red-brown, later becoming dark red-brown. The cremaster is a dense group of hooked setae (fig. 6).

Adults.

Female moths have a wing-span of about 30 mm. to 35 mm., and the males of about 23 mm. to 28 mm.

Coloration of males is variable from pale fawn with a pink suffusion, to dark fawn or grey, and with darker bands of variable width and colour across the wings. Such variation occurs in the one series bred from the same colony of larvae. Female moths are usually pale grey, sometimes lightly suffused pink, with narrow darker grey wavy bands across the wings. The abdomen bears a large tuft of paler coloured scales distally (Pl. 1, fig. 4).

Life-cycle.

The complete life-cycle occupies twelve months, with the various stages occurring on the central coast during the following months:—

Adults: December to March

Eggs: January to May

Larvae: 1st instar, March to June; 2nd instar, April to July; 3rd instar, June to August; 4th instar, July to September; 5th instar, September to November; 6th instar, November to January.

Pupae: December to February.

The various stages are in the collection of the Forestry Commission of N.S.W.

Parasites.

Specimens of *Anamastax* sp. (Tachinidae) have been reared from larvae from Mt. Topper S.F.

Predators.

An adult specimen of *Cermatulus nasalis* Westwood (Hemiptera: Pentatomidae) was collected at Mt. Topper S.F., with its proboscis inserted in a last instar larva, near which were two other flaccid larvae apparently also recently attacked by it.

ACKNOWLEDGMENTS.

The writer is grateful to Mr. D. K. McAlpine of the Australian Museum, Sydney, for assistance with references to the species studied, and the identification of the predator; and to Mr. I. F. B. Common of the Division of Entomology, C.S.I.R.O., for identification of the species and comparison of larvae and adults with closely allied species.

REFERENCES.

Anonymous (C.S.I.R.O.) (1955). "Common Names of Insects." Bull. 275. C.S.I.R.O., Melbourne

Froggatt, W W. (1923). "Forest Insects of Australia," pp. 61-63. N.S.W. Govt. Printer.

Herrich-Schaeffer, G. A. (1853). Ausser Schmet. Lepid. Exot. fig. 510.

Lewin, J. W. (1805). "Prodromus Ent." p. 7. (Coloured pl., 4 figs.). T. Lewin, London.

Seitz, A. (1929). Macrolepidoptera of the World. 10 (2): 381.

Turner, A. J. (1902). Tr. Roy. Soc. Sth. Aust. 26 (2): 184.

——— (1922). Proc. Linn. Soc. N.S.W. 47 (3): 358.

Walker, F. (1855). List Spec. Lepid. Ins. Coll. Brit. Mus. (5): 1156, 1168; (6): 1473. Trustees, British Museum.

——— (1865). ibid. (32): 489, 490, 546, 547 (suppl).

Observations on Some Australian Forest Insects

11. Two Species of Lepidopterous Leaf-miners Attacking *Eucalyptus pilularis* Smith

By K. M. Moore.

(Forestry Commission of New South Wales.)

SUMMARY.

Severe damage to foliage of *E. pilularis* Smith (blackbutt) by the leaf-miners *Acrocercops laciniella* (Meyrick) (Gracilariidae) and a species of the *"Tinea" nectarea* group (Incurvariidae) occurred on State Forests in New South Wales from July to September, 1959.

Some aspects of the biology of the two species of Lepidoptera are recorded and leaf-mines, larval head-capsules and setal maps of larvae are figured. Hosts are given and damage is described.

INTRODUCTION.

Eucalyptus pilularis is of considerable economic importance in New South Wales, being regarded as one of the most valuable hardwood timbers.

Small scattered populations of various species of leaf-miners of the Gracilariidae and Incurvariidae are relatively numerous on many tree-species, but no records of extensive populations of these species in New South Wales could be located. Newman & Clark (Leaflet No. 165, Dept. of Agriculture, Western Australia) reported a large population of tineids, the species of which was not identified, attacking *Eucalyptus marginata* Smith (jarrah) and *E. rubida* in Western Australia. (According to Blakely (1955) *E. rubida* does not occur in Western Australia; and it is probable that the species referred to is *E. rudis* Endl. (moitch).

Severe damage by the two leaf-mining Lepidoptera *Acrocercops laciniella* (Meyr.) (Gracilariidae) and *"Tinea"* sp. (a species of the *nectarea* group within this genus) (Incurvariidae) occurred during the months of July to September, 1959 on *E. pilularis* on Olney and Olney East State Forests (Newcastle Forestry District: Wyong Subdistrict). Damage by both species appeared to be confined to *E. pilularis.* The area of attack was at an approximate altitude of 1500 ft., and extended for several miles along, and on either side of, the Wyong-Olney Road.

(A) *Acrocercops laciniella* (Meyr.).

HOSTS

This species has been reared by the writer from *Angophora floribunda* (Sm.) Sweet (rough-barked apple), *A. costata* Domin (smooth-barked apple), *Eucalyptus triantha* Link (white mahogany), *E. saligna* Smith (Sydney blue-gum) and *E. pilularis.*

DAMAGE.

Foliage of large trees, or coppice and regeneration of all ages and heights, was attacked and presented a brown, fire scorched appearance, distinguishable from a considerable distance. Both young and coarse foliage was almost completely destroyed, and although both upper and lower leaf-surfaces were severely affected, most of the attack occurred beneath the upper leaf-cuticle. When maximum damage was apparent, almost every leaf had been attacked, the younger leaves being curled longitudinally, and the crown-foliage of trees had turned brown. The palisade tissue in a leaf was often entirely destroyed.

Some three months after the attack had ceased, trees had reproduced crown-foliage and the stand did not appear to have been greatly affected. It thus appears that, unless sustained heavy attack occurs, with recurrences of defoliation, the trees are able to recover, with little or no apparent detrimental effect.

MINES.

Initially, the mines are linear, but as the larvae develop they form an extensive white blotch area with the cuticle of the leaf forming a covering above the

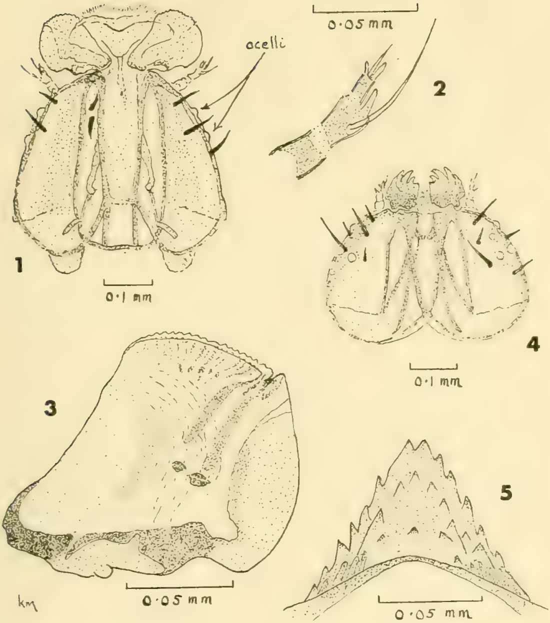


Fig. 1. Head-capsule, 2nd instar larva, *Acrocercops laciniella* (Meyr.), showing dorsal setae on right, ventral setae on left.

Fig. 2. Antenna of 2nd instar larva, *A. laciniella.*

Fig. 3. Mandible of 2nd instar larva, *A. laciniella.*

Fig. 4. Head-capsule, 3rd instar larva, *A. laciniella,* dorsal setae on right, ventral setae on left.

Fig. 5. Anterior spine on pupa, *A. laciniella.*

mine (fig. 9). The cuticle becomes stained with variable amounts of cream to brown discoloration due to the more or less liquid larval excreta in the mine. On *E. pilularis* the cuticle of the blotch area is stained a darker brown than that on the other host-species from which *A. laciniella* has been reared. On *E. pilularis* and *A. floribunda* several mines, which may coalesce, are sometimes constructed in the one leaf and may contain as many as four larvae.

During the two sap-feeding instars when the linear, and some of the blotch area of the mines are constructed, larvae feed on the palisade tissue, and the dark, almost liquid excreta is deposited on the floor of the mine in a serpentine pattern. The floor of the mine later becomes pitted where the larvae feed deeper into the spongy tissues and their excreta becomes more solidified and of pellet-form which is typical of most leaf-eating lepidopterous larvae. This is then distributed in a narrow band around the perimeter of the mine.

EGGS.

The eggs, approximately 0.6 mm. in diameter, are round, dome-shaped, smooth and translucent, the surface attached to the leaf being flattened. After eclosion the chorion is transparent, shiny and clearly visible as a silvery spot at the commencement of the mine. Adults oviposit either on the upper or lower leaf-surface of *E. pilularis* but the eggs have been found to occur only on the lower leaf-surfaces of *A. floribunda, E. triantha* and *E. saligna.* Excreta from a young larva is faintly visible within the chorion as a pale brown stain or as minute red-brown spots deposited as the larva cuts its way through the base of the egg attached to the leaf-surface and commences to mine in the leaf-tissues.

LARVAE.

Larvae of *A. laciniella* may be found during the period March to December, and are at times numerous on *A. floribunda* during October.

The prognathous mouth-parts of the 1st and 2nd instars (figs. 1 and 3) are peculiarly adapted to mine the sappy palisade cells of the leaf-tissues, and enable the larvae to feed only in a forward direction. In the 3rd and 4th instars the head-capsule is more rounded (fig. 4), produced antero-ventrally, and similar to that of other leaf-eating lepidopterous larvae. The altered structure of the head-capsule and mouth-parts thus enables the larva to deepen the floor of the mine by consuming the spongy mesophyl tissues. The oil-glands and the venation of the leaf are avoided by the mining larvae, and remain as raised prominences on the floor of the mine.

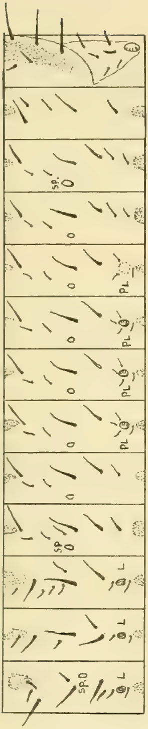
During August and September the larvae feed for approximately six weeks, from eclosion to emergence from the mine through a semicircular slit in the cuticle (fig. 9).

After leaving the mine, the larvae spin pale pink to orange-brown opaque cocoons, satiny in appearance, among the debris on the ground. Cocoons may be found on the under-surfaces of leaves of *Pteridion aquilinum* L. (bracken fern), in curled leaves of *Eucalyptus* spp. and in pieces of curled bark on the ground beneath the attacked trees. When numerous larvae were held in jars, pupation always occurred on the outer surface of the blotch portion of the mine-cuticle.

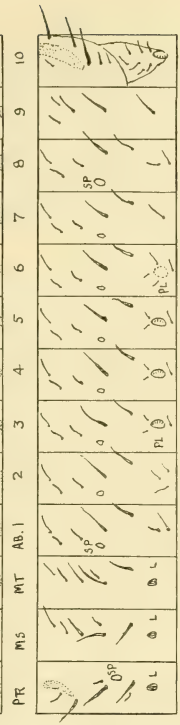
As many as eight small shiny globules, of the same colour as the cocoon, are attached to the external surface of the cocoon during its construction.
Description of larva.

1st instar: Length, approximately 1.5 mm. Head-capsule flattened dorso-ventrally, about as wide as long, with one lateral ocellus only, each side, and nearer to the antenna than the anterior ocellus of the 2nd instar; lateral and dorsal setae absent, but two setae present latero-ventrally; thoracic legs absent and prolegs without crochets.

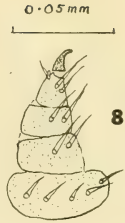
2nd instar: Length approx. 2.5 mm. Head-capsule flattened as in 1st instar; two lateral ocelli each side, and setae as in fig. 1; antennae and mandibles as in figs. 2 and 3; thoracic legs absent and prolegs without crochets.



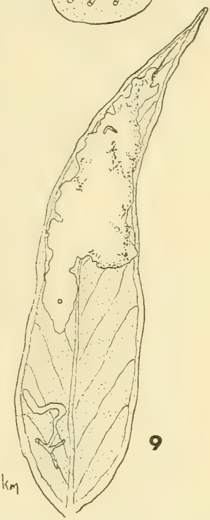
6



7



8



9

Fig. 6. Setal map, 3rd instar larva, *A. laciniella.*

Fig. 7. Setal map, 4th instar larva, *A. laciniella.*

Fig. 8. Prothoracic leg, 3rd instar larva, *A. laciniella,* showing setal arrangement.

Fig. 9. Early-stage mine (lower) and blotch mine, *A. laciniella* on leaf of *E. pilularis.*

Larvae are white, pale yellow or pale green during the first two instars, and during the 2nd instar a prominent medio-dorsal and medio-ventral brown mark is usually present on each segment.

3rd instar: Length approx. 3.5 mm. Head-capsule not flattened, with four ocelli, and setae, as in fig. 4; thoracic legs as in fig. 8; prolegs on abdominal segments 3 to 5, and usually each with three or four crochets, and prolegs on seg. 6 without crochets. A setal map of this instar larva is given in fig. 6.

4th instar: Length approx. 5 mm. Head-capsule similar to that of 3rd instar, but with five ocelli each side; thoracic legs as in 3rd instar; prolegs on abdominal segs. 3 to 5 usually each with six crochets; prolegs on seg. 6 without crochets (fig. 7).

During the last two instars when the spongy mesophyl of the leaf is consumed, larvae are usually pink in colour. During the 3rd instar there may be brown to dark grey medio-dorsal and medio-ventral markings on each segment, but on 4th instar larvae the darkened areas are usually present only on the prothorax and 10th abdominal segment.

PUPAE.

Length approximately 4.3 mm. The pointed prominence on the anterior end of the pupa (fig. 5) bears a series of minute spines. The lateral spines and setae on the abdomen apparently assist the forward movement of the pupa against the end of the cocoon, when the anterior prominence fractures the silken case through which the pupa is protruded to about half of its length at the time of emergence of the adult. The pupal stage occupies about three weeks during September.

ADULTS.

Adults have a wing-span of about 9 mm. The fore-wings are striped longitudinally from the base to the apex with brown, white and gold. At the base of the apex on the posterior margin of the wing, are two small areas of black scales surrounding a few white scales. The hındwings are dark grey, narrow, and edged with grey cilia which are longest on the posterior wing-border. The grey antennae extend to beyond the wing-tips.

When in a resting position the adult is inclined at about 45 deg. to the object to which it is attached. This habit appears to be typical of adults of the Gracilariidae.

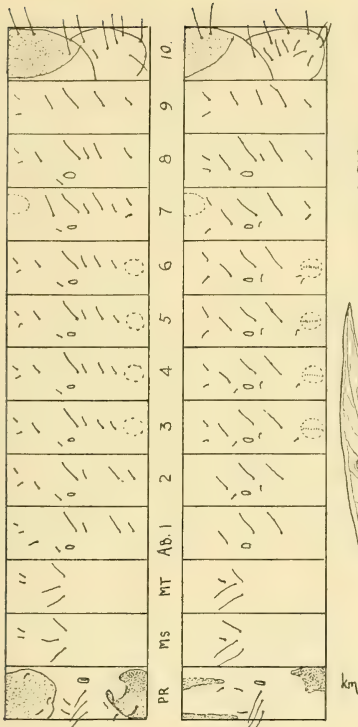
The life-cycle of *A. laciniella* from egg to adult occupies approx. 6 to 8 weeks during September and October, and several generations may occur during the one year.

Unidentified species of the Braconini (Braconidae) and Chalcidoidea were reared from mines of this species. Braconid larvae pupate within the mine, in silken cocoons surrounded by the excreta of the miner. Several small red larvae of the family Cecidomyiidae (Diptera) found in mines where areas of intense black staining denote their presence, were reared to the adult stage. These larvae spin small cocoons in depressions below the black areas in the mines, where they pupate. The function of the cecidomyiids within the mines of *A. laciniella* was not investigated.

(B) A species of the *"Tinea" nectarea* group.

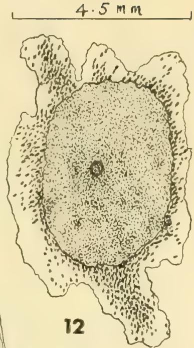
Attack by this species was concurrent with that of *A. laciniella* and sometimes occurred on the same tree. The leaves of the tree-crowns were less affected by this species than by the gracilariids, as the mines were less extensive and considerably less leaf-area was destroyed by the larvae, although as many as 25 individual mines occurred in the one leaf.

Young coppice and regeneration were rarely attacked, and the more mature leaves of the tree-crowns appeared to be the site favoured for oviposition.



10

11



12

13

Fig. 10. Setal map, 2nd instar larva, *"Tinea" nectarea* group on *E. pilularis.*

Fig. 11. Setal map, 3rd instar larva, *"Tinea"* sp. on *E. pilularis.*

Fig. 12. Last instar larva mine, *"Tinea"* sp., on *E. pilularis,* showing future pupal case, and oviposition site near centre.

Fig. 13. Mines of *"Tinea"* sp. on leaf of *E. pilularis.*

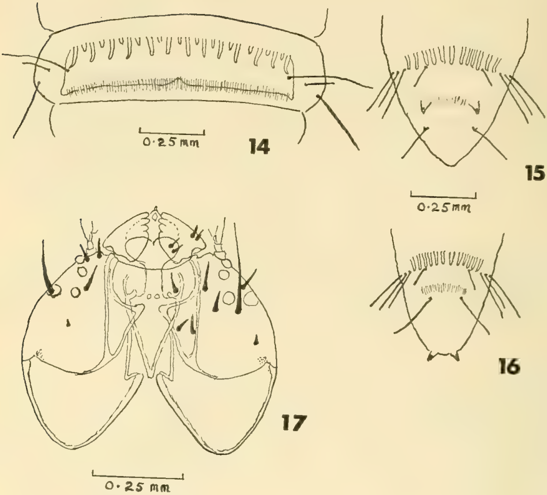


Fig. 14. Dorsal spines and setae on third seg. of pupa, *"Tinea"* sp.

Fig. 15. Dorsal aspect of terminal seg. of female pupa, *"Tinea"* sp.

Fig. 16. Dorsal aspect of terminal seg. of male pupa, *"Tinea"* sp.

Fig. 17. Head-capsule, last instar larva, *"Tinea"* sp. on *E. pilularis*, showing dorsal setae (right) and ventral setae (left).

MINES.

Construction of the mine is commenced at, and extended around, the site of oviposition. During early instars, the larvae destroy the palisade and spongy tissues. Larval excreta is retained in the mine and the upper and lower leaf-surfaces are stained a mottled light and dark brown. During the penultimate larval instar the mines may be oval or round, and during the last instar they are oval in shape (fig. 12). An area beyond the perimeter of the future pupal case is mined, and becomes translucent as the destruction of the parenchyma proceeds and the upper and lower leaf-cuticles only are retained.

When larvae have completed feeding, the excreta is moved to the perimeter of the mine and the upper and lower internal surfaces of the central pupal case are covered with a layer of silk. The dark, oval pupal case containing the larva fractures around its edge, is shed from the leaf and falls to the ground. Pupal cases are approx. 5 mm. by 3 mm. Completed mines are usually found on foliage during August, and this species completes only one generation each year.

EGGS.

The eggs are about 0.4 mm. in diameter, and are inserted beneath the cuticle of the leaf. Oviposition occurs during April and May.

LARVAE.

Approximate lengths of larvae are:—1st instar, 1.0 mm; 2nd instar, 2.0 mm.; 3rd instar, 3.7 mm. Larvae are at first white to pale cream, darkening to cream suffused grey during the last instar. The grey suffusion is caused by numerous minute, flat grey tubercles situated close together on the surface of the exoskeleton.

The head-capsule (fig. 17) is flattened dorso-ventrally during instars 1 and 2, and produced antero-ventrally during instar 3. The head is retractable to almost completely within the prothorax. The prothorax is flattened dorso-ventrally and wedge-shaped toward the anterior border.

Thoracic legs are absent during all instars, but pseudopods are present on thoracic segments 2 and 3, and abdominal segments 3 to 6. Dorsal processes are present on thoracic segments 2 and 3 and on abdominal segment 7 on its posterior half (figs. 10 and 11). During the 3rd instar abdominal pseudopods on segs. 3 to 6 bear a transverse line of small spines or crochets across their centres. During the 2nd instar the minute spines or crochets are barely visible under high magnification.

PUPAE.

Length approx. 2.8 mm. Segments 3 and 7 are shown in figs. 14 to 16. Although pupal cases are usually shed from the leaves during August, larvae do not pupate until March or April of the following year. Pupation usually occupies about 2 to 3 weeks during April, when adult moths commence emerging. The pupal exuviae is protruded to about half its length from one end of the pupal case, remaining attached to it after the adult has emerged.

ADULTS.

Adults have a wing-span of about 5 mm. The forewings are shiny grey-black with a copper-coloured suffusion. Patches of whitish coloured scales tipped yellow are on the posterior border at about one quarter of the distance from the base of the wing, a smaller area near the posterior border at about two thirds the distance from the base, and a few scales sometimes at two thirds from the base; a large patch on the costa at two thirds from the base, and a smaller area at three quarters from the base. Hindwings are grey in colour.

ACKNOWLEDGMENTS.

Thanks are expressed to Mr. I. F. B. Common, of the Division of Entomology, C.S.I.R.O., Canberra, for the identifications of the two species of Lepidoptera.

The Butterflies of the Mallacoota District

By D. F. Crosby, F.R.E.S., F.N.C.V.

The area of Victoria east of Lakes Entrance is an interesting one for the butterfly collector from two points of view. Firstly because of the comparatively little collecting done there, and secondly because that which has been done has yielded records indicating that the area contains a fair proportion of species which are found more abundantly in New South Wales, and generally not elsewhere in Victoria.

In order to more or less explore Eastern Victoria entomologically, the author made trips from Melbourne to Mallacoota in January 1948 and February 1949, the results of these being reported in the "Victorian Naturalist" (Crosby, 1951). Two further visits to Mallacoota were made subsequently, the first in late January 1955, and then in early November, 1956.

The purpose of these notes is to bring up-to-date the information given previously on the butterflies recorded, and to briefly summarize the previous captures.

Hesperilla mastersi Waterhouse, 1900.

Following the first capture of a female on February 10th, 1949, another female was caught in a nearby locality to the southeast of the Mallacoota township on January 30th, 1955. This latter specimen was taken in an open sheltered patch of *Gahnia melanocarpa,* upon which the species may feed, however, a careful search failed to yield any evidence of shelters. In the same general area there were scattered bushes of *Gahnia clarkei* which also could be the foodplant. Further investigation of the bushes in the following November also produced no signs of larvae or shelters. In a recent paper this species has been noted by Burns (1960) as ocurring north of Cann River, which further extends its range eastwards.

Hesperilla picta (Leach), 1814.

This species has been taken from Nowa Nowa, only a few miles east of Lakes Entrance (on *Gahnia clarkei*) through to Mallacoota and nearby Gipsy Point. Males and females have been taken on the wing in late January, February and early March. It is interesting to note that Mr. John Landy took a perfect female on February 17th, 1960 on Wilson's Promontory, which further extends the records to the west by about 150 miles. There are good gullies of *Gahnia clarkei* in various places in the park there.

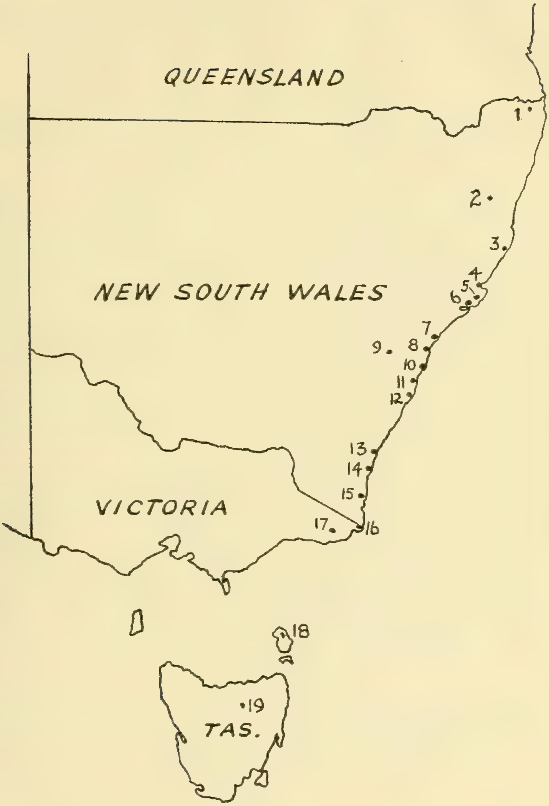
Trapezites maheta praxedes (Plötz), 1884.

Three males in very good condition were taken in a sunny spot beside the road to the east of Mallocoota on January 30th, 1955.

DISTRIBUTION MAP

N. mathewi
2. Ebor
4. Forster
5. Myall Lakes
6. Port Stevens
7. Woy Woy
8. Narrabeen
9. Blackheath
10. Sydney
13. Moruya
14. Narooma
15. Pambula, Merimbula
18. Flinders Island
19. Launceston, Underwood

H. mastersi
1. Mt. Warning
3. Port Macquarie
7. Narara, Lisarow
9. Katoomba
10. National Park
11. Bulli Pass
12. Illawarra, Clifton
13. Moruya
15. Merimbula
16. Mallacoota
17. Cann River


QUEENSLAND
NEW SOUTH WALES
VICTORIA
TAS.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

Trapezites symmomus symmomus Hübner, 1823.

Detailed examination of three further male specimens taken at Mallacoota on January 30th, 1955 together with two taken in February, 1949, at the same locality confirm them to be the New South Wales subspecies. One somewhat intermediate example was taken at Tostaree in early February, 1949, and two further males in January, 1956. These appear to be closer to the typical race rather than *T. s. soma* Waterhouse, 1932.

Appias leis ega (Boisduval), 1836.

In a pleasant sunlit clearing in the forest near the inlet at Mallacoota, four males and two females were caught on January 24th, 1955. All were in perfect condition and apparently bred nearby.

Neolucia mathewi (Miskin), 1890.

In early November 1956 whilst strolling through the forest south of Mallacoota in search of clumps of *Gahnia* where *H. mastersi* may be flying, a shrub about 10 feet high of *Monotoca elliptica* (a common coastal shrub with small starry white flowers, minute orange berries and leaves about $\frac{3}{4}$ in. long and $\frac{1}{4}$ in. wide and spined at the end) seemed to have a large number of small dark butterflies flying round it. A number of these were caught and found to be *Neolucia mathewi*. A further search revealed them around many similar bushes in the sun. As there was a high proportion of males, their season must have only just commenced. This record is of interest as it extends the previously recorded range on the mainland by about 60 miles to the south. Waterhouse (1932), lists it as occurring as far south only as Narooma, and at Flinders Island and North Eastern Tasmania. However there are specimens in the Australian Museum, Sydney, from Merimbula, N.S.W.

In November of the subsequent year a search was made of the coastal scrub around Port Albert, but no signs of the species were seen despite an abundance of the food plant.

The following species were also recorded from the area:

Mesodina halyzia halyzia (Hewitson), 1868. Common, particularly close to the shore.

Toxidia andersoni (Kirby), 1893. Few odd specimens.

Toxidia doubledayi (Felder), 1862. Occasional specimen.

Toxidia parvulus (Plötz), 1884. Rare.

Toxidia peron (Latrielle), 1824. Common.

Delias harpalyce (Donovan), 1805. Common.

Candalides xanthospilos (Hübner), 1806. Common throughout.

Ialmenus evagoras evagoras (Donovon), 1805. Common but local.

ACKNOWLEDGMENTS

The author wishes to thank Mr. C. N. Smithers, Curator of Insects, Australian Museum, Sydney, and Mr. A. N. Burns, Entomologist, National Museum, Melbourne, for their kind assistance in providing distribution data.

REFERENCES

Burns, A. N., 1960, New and Interesting Records of Butterflies for Victoria, *Vic. Nat.* 77 (5): 128-130.

Crosby, D. F., 1951, Notes on Some Eastern Victorian Butterflies, with a New Victorian Record, *Vic. Nat.* 68 (6): 99.

Waterhouse, G. A., 1932 "What Butterfly is That?" p. 171.

Some Notes on the Moths and Butterflies Found Occurring in the Haberfield and Five Dock Districts, Sydney, N.S.W.

By L. Courtney Haines.

The Haberfield and Five Dock areas are known as Western Suburbs of Sydney. Both are old residential districts and until recently still maintained a few relics of convict days in the form of stone steps and sandstone walls. Both suburbs adjoin the shores of Iron Cove Bay, with Five Dock extending as far as Hen and Chicken Bay, a tidal backwater of the Parramatta River.

Before settlement extended on all sides, a "wild" section consisting of several acres was to be found adjoining Iron Cove. These fields, bordered by hedges of Lantana and Blackberry were always of interest to the naturalist and it was here I remember seeing for the first time, those huge butterflies, the Wanderer, *Danaus plexippus*, and the even larger Orchard Swallowtail, *Papilio aegeus aegeus*.

Nowadays, the only area that still remains unspoiled is Rodd's Peninsula, a narrow neck of land extending out into Iron Cove. This peninsula is covered with coarse grasses, Lantana and a creeping vine *(Kennedya rubicunda)*. A few trim blue-leaved shrubs *(Notelea longifolia)*, a native food-plant of the Casuarina (privet) Hawk Moth *(Psilogramma menephron casuarinae)* are also to be found, while several small Rough-barked Apples *(Angophora floribunda)* manage to survive on the wind-blown crest of the peninsula. The latter is one of the food-plants of a large and lovely Lappet Moth.

Around the foreshores of Iron Cove are patches of Salicornia, Salt bush and Sedge and here may be found those little unobtrusive butterflies, the Chequered and Salt-pan Blues *(Neolucia serpentata* and *N. sulpitius sulpitius)*; their eggs, caterpillars and chysalids, always being safely esconced on their food-plants, just above high-tide mark!

Kunzea bush, called locally Tea-tree, and the food-plant of a very elegant Notodont Moth, at one time grew plentifully about the districts, but is now, except for a few retained in gardens, entirely absent, as is also the case with the Wattles. Although most of the residents are keen gardeners they appear to be, unfortunately, devoid of an appreciation of trees. Apart from the Box-brushes, therefore, *(Tristania)* is lopped down outrageously each summer when their shade would be most welcome, and a few Pepper trees *(Schinus mollis)* bordering the quiet side streets, together with a number of Eucalypts growing in the several painfully well kept parks, very few trees break the monotony of the red tiled and grey slate roofs which seem to stretch as far as the eye can see.

The majority of day-flying moths and butterflies observed or captured have been visitors to my garden, lured there by various sweet-smelling flowers. Foremost among these is Buddleia, which nothing can rival; its mauve flowers, exuding a scent resembling that of old honey, are attended throughout the day by the larger butterflies and skippers. The day-flying vine moths are also very partial to its fragrance. Moths possessing flight periods of a crepuscular nature, do not appear to be particularly charmed by the Buddleia blooms, but instead favour the Petunia beds, California Poppies, Honeysuckle flowers and the blooms of Pittosporum. Loquat tree blossoms and the sweet-smelling Privet flowers also attract numerous moths belonging to the Noctuid family. The garden pest, known as Wild Kapok *(Araujia albens)* which will climb everywhere if one permits it to do so, not only claims the attention of the little Hawk Moth *(Hippotion scrofa)*, but also snares it by the proboscis while it is busy probing the depths of the flowers for nectar. I have, on occasions, set the little fellows free, by gently withdrawing their long tongues. The already-mentioned California Poppies also trap these little hawks but not being as tenacious as the Wild Kapok flowers the moths after a while of frenzidly beating their wings, usually gain their freedom.

The street lamps at night are sometimes worth a visit with the long-handled net, and on occasions, interesting moths have been added to the collection. One remarkable capure made at a lamp facing the water-front, was an almost perfect

male *Xyleutes lituratus* (Cossidae). Another "good thing" taken on the lamps was the Scarce Emperor *(Antherea helena),* a silk moth of large size, usually associated with mountainous districts. The more common Emperor Gum-moth *(Antherea eucalypti)* is sometimes quite numerous around the lamps. Its eggs are deposited on the leaves of the Box-brushes, Pepper trees and the Rough-barked Apple-gums. I have bred out some very attractive forms of this most variable species. It is indeed remarkable, as the following will show, the number of species of Lepidoptera that the persevering collector can find in such well-settled districts, possessing no bush-land, few trees and fewer open places.

Division: HETEROCERA (The Moths).

The Macro-lepidoptera.

Family Sphingidae, Hawk Moths.

1. *Chromis erotus* Cramer. Orange Underwing Hawk. Rare, two captures only, the first in 1937 and the second during the summer of 1946. Both were found on the footpath beneath the same lamp, in damaged condition.
2. *Ascosmeryx cinerea* Butler. Olive-shades Hawk. One specimen only, taken as it flew in to light through an open window on 6th March, 1959.
3. *Psilogramma menephron casuarinae* Walker. Casuarina Hawk-moth, also known as the Privet Hawk and the Grey Hawk. A fairly common species, the males of which are capable of producing a high pitched rasping sound. The handsome caterpillars are often found feeding upon the Privet hedges and garden Lilacs. I have also found larvae feeding on Blue Bush *(Notelea longifolia),* a native shrub, several of which thrive on Rodd's Peninsula.
4. *Herse convolvuli* L. Convolvulus Hawk-moth, also called Pink-banded Hawk. Frequently observed at rest on lamp posts. The caterpillars, which are variable in colour, feed upon Convolvulus Vine and Sweet Potato leaves.
5. *Hippotion scrofa* Boisduval. Vermillion Under-wing Hawk. A charming small species, which is sometimes reasonably plentiful. It is attracted readily to the garden sweets during the early part of the evening; but as the shades of night deepen, it becomes less active, and adjourns to various resting places, such as lamp-posts, fences, or very often curtains in the vicinity of open windows. The forewings of this species are very variable in colour.
6. *Hippotion celerio* L. Silver-striped Hawk. Several captures of this elegantly marked Hawk. Like the preceding species, the Silver-striped Hawk does not hesitate to enter an open window or doorway, to be discovered later in some obscure corner.

Family Notodontidae, The Prominents.

7. *Epicoma melanospila* Walker. Barred Satin Moth. Wherever *Kunzea* bush flourishes this attractive moth will be found. In days gone by a series of a dozen or more could be taken during a single evening. The method of capturing specimens was a simple one; all one needed was an oil-burning lantern, showing a dispersed yellowish light, with which to search the outer foliage and a killing-bottle, into which the resting moths were deftly flicked with a finger. If the lantern produces too concentrated a glare, this moth will either fly or drop immediately into the long and tangled herbage usually growing at the foot of the bushes, thus eluding its would-be captor. The males differ from the females by possessing a black bar on the forewing; this adornment is in addition to the black spot, which occurs on the forewings of both sexes.
8. *Epicoma tristis* Lewin. Frosted Brown. One record only and that was a female captured during the late afternoon of November 24th, 1951, in an extensive garden surrounding an old manor house, now demolished.
9. *Trichetra sparshalii* Curtis. Buff-tailed Satin. One female taken on 11th April, 1952. It was resting on a Boxbrush *(Tristania)* leaf, on which were a freshly deposited batch of eggs, protectively covered with the moth's anal hairs.

Family Lymantriidae, Tussock Moths, Vapourers and Brown-tails.

10. *Euproctis crocea* Walker. Yellow Tussock. One specimen collected on 3rd April, 1943.
11. *Ascyphas chionitis* Turner. Golden-tailed Moth. A common garden species possessing a short flight period during the twilight hour. The caterpillar is black, covered with hairs, and adorned with red and white spots, and like the imago is

very active, appearing always to be in a hurry. It feeds on various plants, among which tender roseleaves are a favourite.

12. *Laelia obsoleta* Fabricius. Creamy-winged Tussock. The hairy caterpillars of this species, sometimes occur commonly on the foliage of the Angophoras growing on Rodd's Peninsula. Except for their larger size, the caterpillars closely resemble in appearance those of the next species.

13. *Orgyia anartoides* Walker. Australian Vapourer. A prettily marked moth in which the females are entirely wingless. Because of their inability to fly, nature has provided them with an attractiveness so acute, that frollicking gaily dressed males are lured from afar, and guided unerringly to these hidden charmers of the night. This attractiveness, more highly developed in some species than others, is known as "calling." I have found the caterpillars of this species feeding on *Angophora* and an exotic shrub which appears to be one of the Coniferae. They have also been recorded feeding on Geraniums.

14. *Lymantria reducta* Walker. White Cedar Moth. A common dingy species the caterpillars of which ravage and utterly destroy White Cedar trees *(Melia azedarach)*. These rather horrid looking larvae cluster in great masses around the trunks of their food-plants during the day, and it is then that they can be eliminated. The only effective way is to squash them all with a flat stick. They seem to possess some kind of sense, as those that escape death by dropping into the grass wander off and make a "camp" elsewhere only to return again each evening to feed on the leaves of the stricken trees.

Family Anthelidae, Woolly Bears.

15. *Anthela acuta* Walker. Common Anthela. A common species, subject to great variation in size, colour, and markings. The larvae are usually called "hairy grubs" and feed on any soft grasses. They are quite harmless and have a curious habit of curling up when disturbed or alarmed.

16. *Anthela ocellata* Walker. Black-spotted Anthela. This moth is somewhat variable, and during certain seasons is rather common. The newly emerged females readily assemble the males, and it appears from experiments I carried out some years ago, that the darkened hours of the morning is the period used for this purpose.

17. *Anthela ferruginosa* Walker. Reddish Anthela. Rather scarce, occasional specimens attracted to light. The species is variable, ranging in colour from red, which is the most common form, to greyish-brown. One striking example I possess, has fawn forewings and red hindwings. The caterpillars of *A. ferruginosa* are somewhat smaller than those of *A. acuta* and *A. ocellata* and are covered with reddish hairs.

Family Lasiocampidae, Lappet Mothes, Lackeys, Eggars and Drinkers.

18. *Entometa fervens* Walker. Australian Lappet. A large and handsome species. The eggs are deposited each summer on the leaves of the Rough-barked Angophoras growing on Rodd's Peninsula. The large caterpillars are coloured according to the twigs upon which they rest. Those that sleep by day on the grey bark covered trunk of their food-plant, are grey—those found on freshly grown twigs are some shade of brown, and again, it will be observed, that caterpillars of a patchy grey and brown appearance, lie upon sections of the bush which have begun to shed pieces of bark, and thus harmonise perfectly with the mottled twig to which they cling.

As yet, I have not carried out the necessary experiments to determine whether these fascinating creatures are capable of changing their colours at "will" to match that upon which they happen to find themselves, or whether they merely select that part of the trunk or stems which cryptically affords them the best concealment.

The following extract taken from H. W. Shepheard-Walwyn's interesting book "Nature's Riddles," tells of Professor E. B. Poulton's experiments many years ago at the Oxford University Museum, with caterpillars of the British Lappet Moth *(Lisiocampa quercifolia* L.)

"He (Poulton) obtained a batch of Lappet Moth eggs and provided some of them with twigs of hawthorn covered with grey lichen, while the remainder were placed upon twigs of a normal brown colour, and he was very careful to

see that the same sort of twigs were always given to the same caterpillars, so that one batch should always have the lichen covered twigs and the other batch the brown ones. The consequence was, that the caterpillars which were kept upon the lichen twigs gradually developed grey markings on their upper surfaces, in exact imitation of the grey lichen; whereas those which were among the brown twigs remained the normal brown colour, with the result that each was equally invisible when reposing upon its particular twigs. Thus, when the caterpillars were full-grown, those from one batch were totally different from the others, although they were all of the same brood and the progeny of the same parent. This very interesting and conclusive experiment I (Shepheard-Walwyn) subsequently repeated myself, and obtained the same results as those which Mr. Poulton had shown me."

Although the Australian Lappet Moth caterpillars are extremely well camouflaged, they by no means escape the attacks of Ichneumon flies, and very few indeed attain the adult state. The coarse white silken cocoons, surrounded by two or three leaves to which they are gummed, are quite easy to find, and the moths emerge, as a rule, during late afternoon. A good deal of variation occurs, both in size and coloration in the males, while variations of a less obtrusive nature may be looked for in the females.

19. *Digglesia australasiae* Fabricius. Lesser Lappet Moth. One capture only. On the evening of April 8th, 1951, a specimen was picked up in the rays of the lantern, as it rested on outer foliage of a Privet bush, and was successfully netted.

20. *Porela arida* Walker. Pastel Shades Moth, Rabbit Moth. The clustered groups of grey eggs, and the hairy, though attractive caterpillars of this lasiocampid are often to be found on *Angophora, Kunzea* and to a lesser extent *Tristania.* I have never known the moth to be attracted to light, but specimens may be easily found with the aid of a lantern, late at night, resting on their respective food-plants. If one intends to raise moths from the larval stage, the caterpillars must be collected when quite small, otherwise there is a possibility of them being parasitized by a smalt wasp, the maggots of which eat the internal organs, being careful however, not to mortally wound their host until they (the wasp larvae) are ready to pupate. It is not an uncommon sight therefore, to find dead caterpillars clinging to a twig, literally covered with the small white cocoons of the enemy which caused them such a lingering death. The crysalids of this moth are enclosed in a greyish, softly woven cocoon, around which a few leaves are fixed.

Family Saturniidae, Emperor and Atlas Moths.

21. *Antherea eucalypti* Scott. Emperor Gum Moth. A common species. The white elongated eggs of this variable moth are often to be found deposited side by side in neat little groups of three or four, usually on the underside of a leaf. I have found the huge caterpillars feeding on *Angophora* (Swamp Mahogany), a Eucalypt that thrives in salt impregnated soil, *Tristania,* and Pepper Tree *(Schinus mollis).*

The cocoons are composed of tough silk, and are of two types, depending on where the fully-fed caterpillar decides to spin up. Those glued to twigs amidst outer foliage are usually of a golden colour and unadorned in any way; but cocoons located adhering to tree trunks are camouflaged with particles of bark, and appear as nothing more than a slight swelling on the tree.

I have not as yet been successful in assembling with this species, but I distinctly remember W. H. Mason, a natural-history minded school friend, telling me many years ago, how he had attracted and caught numerous Emperor Gum-moths by keeping a freshly emerged female in a cage.

22. *Antherea helena* White. The Pink-lined Emperor, also called Scarce Emperor. A remarkable capture of a male in fairly good condition was made at a street lamp, by the late M. Clayton, during spring of 1940. The vernacular name of this large silk moth is derived, not from the moth itself; but from its caterpillar which possesses two pink lateral lines, one on either side. These lines immediately distinguish it from the larvae of the preceding species, which has yellow lateral lines.

Family Arctiidae, Tigers, Ermines and Footmen.

Sub-Family Arctiinae, Tigers and Ermines.

23. *Ardices glatignyi* Le Guillon. Garden Tiger. At one time very common, nowadays rare in the district.
24. *Ardices curvata* Donovan. Red Tiger. Not uncommon. A great deal of variation occurs in the forewings of this species, some being almost black, while others are so sparingly marked as to appear at first glance a different species. In this respect, *A. curvata* resembles the very variable British Wood Tiger (*Parasemia plantaginus* L.). Wood Tigers are, however, partly diurnal, the males flying during the afternoon in their search for the females, which are mainly nocturnal and in this respect, differ greatly in habits from *A. curvata,* in which both sexes are entirely nocturnal. The larvae are hairy and extremely lively, and I have found them feeding on soft grasses.
25. *Diacrisia canescens* Walker. Golden-marked Ermine. Some years quite common. Usually observed on the wing during the twilight hour.

Sub-Family Lithosiinae, Footmen.

26. *Manulca replana* Lewin. Common Footman. During the years 1949, 1950 and 1951, this footman was quite common. I first observed caterpillars of the moth one evening on a paling fence, thinking that they were looking for a place to spin up, I collected a few and placed them in a large pill-box but after a day or two, they all died. Obviously, they had been clinging to the fence for reasons other than that which I had assumed. Making another inspection of the palings. I again found a batch of the caterpillars, all apparently in a state of coma, but on examining the palings closely under a pocket lens, I was surprised to find growing on them, a micro-lichen, and it was upon this that the caterpillars were grazing.
27. *Utethesia pulchella* L. Crimson-speckled Footman. Several captures of this pretty moth have been made. The species is usually regarded as nocturnal, although I have seen odd ones on the wing during the day. *U. pulchella* is also found in England, where its larvae are said to feed on the Common Forget-me-not (*Myosotis*).
28. *Halone sinuata* Walker. Orange-underwing Footman. A common species which is on the wing from September to March. I can always be sure of finding specimens at rest on the brick wall of my house. Its period of flight seems to be just after day-break.
29. *Azure cervicalis* Walker. Orange-spotted Footman. Two only taken on the mornings of November 17th and 22nd, 1959.
30. *Azure lydia* Donovan. Common Bush-footman. A day-flying species, rarely observed in areas other than woodlands. One capture only—March 24th, 1951.

Family Noctuidae, The Owls, Millers and Semi-loopers.

Other than the day-flying Agaristas, the majority of moths belonging to this extremely large family appear on the wing in wild erratic flight at the first shades of night. They are greatly attracted to the blossoms of *Kunzea,* Privet, Pittosporum, Loquat, various flowering shrubs, as well as many garden flowers. Later in the evening when feeding and courtship is over, the Noctuas are readily attracted to light. With the exception of those indicated as otherwise, the following species are all more or less common in the Haberfield and Five Dock districts.

Sub-Family Agaristinae, Day-flying Vine Moths.

31. *Cruria donvani* Boisduval.
32. *Agarista agricola* Donovan. Painted Moth. One taken at *Kunzea* flowers on 31st December, 1956.
33. *Comocrus behri* Angas. Two specimens netted while attending the flowers of the Buddleia; 2nd November, 1958 and 9th March, 1959.
34. *Phalaenoides glycinae* Lewin.
35. *Phalaenoides tristifica* Hubner. At one time, this dainty lover of rank grasslands and water meadows was reasonably common in open spaces bordering Iron Cove, but nowadays its only stronghold in the district is a tiny corner of grass and sedge converging on Canada Bay, Five Dock. Unlike the four Agaristas already mentioned, which fly high and far, gentle *P. tristifica* loves to

flutter low over the sedges and lank grasses, and never wanders far from its breeding haunts. It is therefore, an exceedingly local species.

Sub-Family Acronyctinae.

36. *Cosmodes elegans* Donovan.
37. *Periphyra sanguinipunctata* Guenee. Extremely rare—one taken many years ago; a second specimen captured on the evening of March 5th, 1962.
38. *Prodenia litura* Fabricius.
39. *Callogramma festiva* Donovan. Lily Moth. Common during April, 1956. The black, yellow and white striped caterpillars of this moth were found breeding on Oliviers.
40. *Ariathisa hydraecioides* Guenee.
41. *Ariathisa tortisigna* Walker.
42. *Euplexia nigerrima* Guenee.
43. *Bathytricha truncata* Walker.
44. *Thalatha hieroglyphica* Turner. Two specimens bred out on March 3rd and April 7th, 1958, from caterpillars found feeding on Angophoras, growing on Rodd's Peninsula.
45. *Spodoptera mauritia* Boisduval.
46. *Amphioggia chordophoroides* Lucas.

Sub-Family Agrotinae = Euxoinae.

47. *Agrotus infusa* Boisduval. Bogong Moth.
48. *Euxoa porphyricollis* Guenee.
49. *Heliothus rubrescens* Walker.
50. *Graphiphora compta* Walker.

Sub-Family Melanchinae.

51. *Persectania ewingii* Westwood.
52. *Sideridis unipuncta* Haworth.
53. *Sideridis uda* Guenee.
54. *Dasygaster hollandiae* Guenee.
55. *Tiracola plagiata* Walker. One specimen only taken on 2nd November, 1952.
56. *Polia consanguis* Guenee.

Sub-Family Erastriinae.

57. *Amyna natalis* Walker. Whistling Garden Moth.

Sub-Family Euteliinae.

58. *Pataeta carbo* Guenee. One specimen taken at dusk on 29th January, 1960. I was rather surprised to take this curious little Noctua so far south, as I had always regarded it as a northern species. When collecting moths for the late Dr. A. Jefferis Turner in the Wallangarra and Stanthorpe districts, Southern Queensland, *P. carbo* frequently came to my lamps.

Sub-Family Acontiinae.

59. *Earias smaragdina* Butler. A charming small green species, sometimes occurring on Rodd's Peninsula.
59a. *Acontia amata* Walker. A single specimen of this northern species taken on February 28th, 1962.

Sub-Family Noctuinae.

60. *Pantydia sparsa* Guenee.
61. *Panilla impropria* Walker.
62. *Catephia acronyctoides* Guenee.
63. *Sandava scitisignata* Walker.
64. *Bertula xyctiphanta* Turner.
65. *Hydrillodes lentalis* Guenee.
66. *Anomis crosa* Hubner.

Sub-Family Catocalinae.

67. *Sericea spectans* Guenee. Common Cloak Moth.
68. *Sericea mutabilis* Turner. Scarce Cloak Moth. A specimen of this extraordinary moth came to light on 30th November, 1959. It appears to be not anywhere common.
69. *Dasypodia cymatodes* Guenee. Dingy Cloak Moth.
70. *Dasypodia selenophora* Guenee. Golden Cloak Moth. One specimen taken on 14th December, 1952. This moth is golden-yellow on the underside and is a

much finer species than *D. cymatodes* which is generally duller in appearance on the upper surface of the wings and dusky grey on the undersides.
71. *Achaea janata* L.
72. *Chalciope hyppasia* Cramer.
73. *Grammodes oculicola* Walker. A single example observed on Rodd's Peninsula, autumn, 1958.
74. *Anna parcemacula* Lucas. Numerous larvae occurred on *Angophora* on Rodd's Peninsula during March, 1947. I was successful in rearing only one to the adult stage.

Sub-Family Phytometriinae.
75. *Phytometra albastriata* Brem and Gray.
76. *Plusia chalcites* Esper. Silver Y Moth.
77. *Plusia argentifera* Guenee.
77a. *Mocis (Remigea) aolosa* Butler.

Sub-Family Hypeninae.
78. *Bracharthron ossicolor* Rosenstock.
79. *Simplicia robustalis* Guenee.
80. *Rhapsa suscitalis* Walker.
81. *Nodaria armatalis* Walker.
82. *Hypena masurialis* Guenee.

Sub-Family Ophiderinae.
83. *Artigisa impropria* Walker.

Family Syntomidae Ringed Moths.
84. *Syntomis annulata* Fabricius. Occasionally taken on the Buddleia flowers. It is a day-flying species and is to be met frequently in the bushland around Sydney.

Family Hypsidae. Greater Ringed Moths and Spotted Moths.
85. *Nyctemera amica* White. Several specimens of this diurnal species have been taken. It is particularly common on the sand-dunes surrounding soaks at the back of Cronulla Beach, Sydney.

Family Geometriidae. Emeralds.
86. *Urolitha bipunctifera Walker*. A common, pretty, green species which is often found resting on the underside of *Pittosporum* leaves late at night. Most of my captures have been made in September and March, although examples have been taken as early as July and as late as April.
87. *Chlorocoma externa* Walker. Uncommon. The caterpillars feed on Wattle. Three specimens bred during January and February, 1959.
88. *Terpna metarhoides* Walker. Three specimens only of this elegant species. The first being bred from a larva found feeding on Angophora, 2nd April, 1950, and the other two taken *in copula* on 1st January, 1960.
89. *Gelasma rhodocosma* Meyrick. One specimen bred out on 17th January, 1955, from a larva found feeding on Angophora.
90. *Crypsiphona occultaria* Donovan. Grey-shades Moth. This attractively marked grey moth with its striking crimson and black patch on the underside of the wings, is easily bred out from the smooth green caterpillars found commonly on the Angophoras. Unlike the Geometers which rest with wings held up butterfly-like, *C. occultaria* flattens out, and in this attitude can easily be mistaken for a Boarmia.

Family Sterrhidae. Wave Moths.
91. *Leptomeris rubraria* Doubleday. Ruby Wave Moth. A fairly common small species, often found frequenting the foreshores of the bay.
92. *Scopula perlata* Walker. Common Wave Moth. Common garden species.

Family Larentiidae. Carpet Moths.
93. *Xanthorhoe subidaria* Guenee. Common, often attracted to *Kunzea* blossoms, also to light. A rare fawn-coloured variety is occasionally captured.
94. *Poecilasthena thalassias* Meyrick. A delicate pale green moth, which was remarkably common during the summer of 1947. I always found it active at dusk, flitting about one particular corner of the garden in which clumps of Aspidistras and ferns were growing. I have only taken occasional specimens since.

95. *Euchoeca rubropunctaria* Doubleday. Rather scarce in the district. This species is subject to some interesting variations.
96. *Scotocyma euryochra* Turner. Extreme variations occur in this species. Two captures only, 16th September, 1947, and September, 1954.
97. *Eucymatoge callizona* Lower. Two only. July, 1949 and March 1st, 1950.
98. *Chloroclystis laticostata* Walker. Rare, one specimen taken on 28th December, 1950.
98a. *Chloroclystis filata* Guenee. One specimen taken on 31st October, 1961.
99. *Xanthorhoe brujata* Guenee.
100. *Euphyia subrectaria* Guenee. Two specimens taken—March 8th and 9th, 1960.

Family Oenochromatidae. Australian Thorns.

101. *Adeixis inostentata* Guenee. One specimen bred from a larva found on Wattle, 16th January, 1959.

Family Boarmiidae. Flat Moths.

102. *Ectropis subtinctaria.* Guenee. The caterpillars feed on Privet, *Kunzea, Pittosporum* and probably other plants.
103. *Ectropis excursaria* Guenee. A variable species, in which a very distinctly marked form sometimes occurs.
104. *Lophodes sinistraria* Guenee. Frequently attracted to light. The black males are far more common than the fawn coloured females. The caterpillars feed on Wattle and *Kunzea.*
104a. *Idiodes apicata* Guenee. Rather infrequent.

Family Zygaenidae. Burnet and Forresters.

105. *Hestiochora tricolor* Walker. Tricoloured Burnet. A specimen was bred out from a very active little caterpillar found feeding on Eucalypt, in 1942. The full-grown larva was an inch long, covered with reddish-brown hairs, longer at each end, and made conspicuous by possessing a white dorsal patch. The small oval chrysalis, light-brown in colour, was enclosed in a semi-transparent silken cocoon.

Family Limacodidae. Cup Moths.

106. *Doratifera vulnerans* Lewin. Painted Cup-moth. Common species, its larvae feeding on *Tristania,* pepper Trees and *Angophora.*
107. *Doratifera quadriguttata* Walker. Common Cup-moth. A fairly common moth, which deposits its eggs on the same food-plants as *D. vulnerans.* The caterpillars have not the same stinging potential as the preceding species, nor do they "top-off" their cocoons with a well defined lid. I have never at any time, seen either *D. vulnerans* or *D. quadriguttata* on the wing, and have obtained all my specimens by breeding.

Family Psychidae. Bag Moths.

108. *Entometa ignoblis* Walker. Faggot Case-moth. Throughout the years three specimens of the plain brown males of this species have been captured. All were attracted by light, and were in perfect condition.
109. *Metura elongata* Saunders. Saunder's Case-moth. Reasonably common garden species. The large silken cases adorned with short twigs are often observed attached to fences.
110. *Thyridopteryx hubneri* Westwood. Leaf Case-moth. This species is not at all common.
111. *Thyridopteryx herrichii* Westwood. Ribbed Case-moth. During years gone by, frequently found; but nowadays extremely rare in the district.

Family Xyloryctidae. Burrowing Moths.

112. *Maroga unipunctata* Walker. Cherry-tree Borer. Some years more common than others. It is readily attracted to light.

Family Cossidae. Wood Moths.

Sub-Family Zeuzerinae.

113. *Xyleutes lituratus* Donovan. One male in fairly good condition taken at rest on a lamp-post on the evening of January 15th, 1951. This extremely interesting capture was nearly overlooked as I assumed it to be at first glance nothing more exciting than a common Privet Hawk. However, after by-passing it for a hundred

yards or so, it suddenly struck me that the moth I had seen was "resting up" in a most extraordinary manner for a hawk. Whereupon I immediately retraced my steps to the lamp in question and to the reposing moth, which turned out to be a new record for the district. Not having a net with me, it was necessary to climb onto a fence, fortunately near at hand, and reaching up, seize the moth in my fingers. Carrying it in this fashion, I reached home and a killing-jar, without causing any noticeable damage to its plumage.

Family Hepialidae. Swift Moths.

114. *Perissectis australis* Donovan. Common species during February and March. The males are exceedingly variable.

115. *Oncopera alboguttata* Tindale. One specimen captured at light during March 1954.

116. *Charagia lignivorus* Lewin *(venusta* Scott). The beautiful green and pink female of this species came to light on the evening of March 13th, 1960.

The Micro-lepidoptera.

Family Tineidae. The little moths belonging to this family are quite numerous, and are to be found flitting about the garden during the dusk of the evening. A common, though attractive species, in which the fore-wings are silvery-white, patterned with brown, is *Monopis nivibactella* Walker.

Family Glyphipterygidae. Metallic Moths.

Cebysa leucoteles Walker. A common garden species during March. The males suddenly make their appearance a little after midday and remain on the wing in wild erratic flight for at least two hours, when they all at once disappear with no further sign of them until the sun is again at its zenith the following day. The females have only partially developed wings, and because of their inability to fly, readily assemble the swarming males. I have often found females running in an agile manner about garden paths. The larvae live in silken bags covered with scraps of bark or lichen.

Family Oecophoridae.

Well represented, the most striking of which is *Cormotypa fascinalis* Fabricius, a species possessing yellow forewings, banded with purple.

Other interesting species are *Borea confusella* Walker, having black and white marked forewings and *Leptocroca sanguinolenta* a species possessing blood-red colours and occurring only in July and early August. A common dingy species is *Philobota xiphostola* Meyrick.

Family Tortricidae. Bell Moths, Leaf Rollers.

Cacoecia australana Lewin. Two examples, collected on 18th September, 1946 and 16th September, 1947.

Family Pyraustidae.

Mecyna gilvata Fabricius. This handsome species, with rather variable forewings, is sometimes fairly common.

Semioceros murcalis Walker. One specimen, 26th September, 1947.

Hymenia recurvalis Fabricius. Common.

Lygropia quaternalis Zeller.

Polygrammodes localis Walker. A single capture at light on 2nd January, 1955.

Musotinna nitidalis Walker.

Atelocentra chloraspis Meyrick. Scarce. All four specimens in my collection have been found resting on *Pittosporum* leaves.

Sylepta clytalis Walker. One specimen collected at light, 23rd March, 1959.

Heliothela ochreipennis Butler. One specimen taken at light, 22nd March, 1959.

Family Pyralidae. Pearl Moths.

Sub-Family Pyralinae.

Endotricha pyrosalis Guenee. A common garden species, the sexes differing both in colour and markings.

Endotricha docilis Walker. Rare, one capture, 27th December, 1950.

Scenedra decoratalis Walker. Three specimens only. This species is variable and ranges in ground colour from pale brownish to black.

Pyralis farinalis L. An extremely common introduced species.

Family Schoenobiidae. Rush Moths.

Scirpophaga patulella Walker. A pure white moth inhabiting boggy places. It is usually found clinging head upwards to rushes or grass-stems, around which it clasps its wings.

Family Crambidae. Grass Moths.

Talis relatalis Walker.
Talis plentiferella Walker. Both species fairly common in grassy fields before settlement.

Division: RHOPALOCERA (The Butterflies).

Family Papilionidae. Swallowtails.

1. *Papilio aegeus aegeus* Donovan. Orchard Butterfly. Males are usually observed during November and March. The females, however, are less frequently seen.
2. *Papilio anactus* Macleay, Dingy Swallowtail. This butterfly is readily attracted to Buddleia flowers, and is then not difficult to net.
3. *Papilio sarpedon choredon* Felder. Blue Triangle. An extremely common species, greatly attracted to Buddleia. Blue Triangles are fond of flying about a restricted area for hours at a time, and will immediately chase into neutral territory any other butterfly that happens to intrude into their domain. The caterpillars are to be found on the tender leaves of the introduced Camphor laurel tree, *Camphor camphora*. Specimens raised in captivity never assume the beautiful blue of those "born" in the wild state; but are instead, a pale washed-out colour.
4. *Papilio macleayanus* Leach. Green Swallowtail. This true swallowtail is rarely seen and I have only two records of it occurring in the district. The first, a capture on 20th January, 1955 and the second, an observation the following season.

Family Pieridae. Jezabels, Whites and Yellows.

5. *Delias nigrina* Fabricius. Common Jezabel. Fairly common during late Autumn.
6. *Delias harpalyce* Donovan. Imperial Painted White. Since the year 1935, when enormous numbers occurred, very few specimens of this striking butterfly have been seen. My last capture was a perfect male, taken at Privet flowers on 19th December, 1959.
7. *Delias aganippe* Donovan. Wood White. Extremely scarce, two specimens only, and both netted at Buddleia.
8. *Delias nysa nysa* Fabricius. Nysa Jezabel. Nowhere common. I have only taken two specimens of this butterfly, and both in my garden. The first in the autumn of 1940 and the second at Buddleia on April 12th, 1956.
9. *Delias argenthona argenthona* Fabricius. Northern Painted White. A tattered female was captured in Haberfield during the summer of 1955 and is probably the first authentic record for Sydney. (cf. "Proceedings of the Royal Zoological Society of New South Wales," 1957-58, page 27.)
10. *Catopsilia pyranthe pythias* Waterhouse and Lyell. Common migrant. Rather scarce, several specimens only.
11. *Catopsilia pomona pomona* Fabricius. Lemon Migrant. A tattered male of this rare visitor was netted at Buddleia on 22nd November, 1959.
12. *Appias paulina ega* Boisduval. Common Albatross. Several specimens captured.
13. *Anaphaeis java teutonia* Fabricius. Caper White. My first experience of Caper Whites occurred in the afternoon of October 23rd, 1938. I happened to be collecting butterflies in a field in Five Dock, when the first specimens began to appear and being quite new to me, each one as it floated over a hedge growing down one side of this particular hunting ground of mine, was madly pursued. Within an hour, however, they began turning up in thousands and it became quite obvious that a butterfly migration was taking place. All the Caper Whites collected that day were later destroyed on the setting-boards by a mouse. I witnessed another similar flight of this remarkable species during the month of December, 1947. Since then, odd specimens are usually found sampling the Buddleias each summer.
14. *Pieris rapae* L. Small White. An introduced species from Europe and at one time very common; but since the introduction of a small parasitic wasp

which attacks the larvae of *P. rapae*, it is fortunately not nearly as numerous as it once was. The eggs of this butterfly are deposited on Cabbage and Nasturtium leaves.

15. *Terias hecabe sulphurata* Butler. Common Grass Yellow. My first capture of this pretty yellow butterfly occurred in a grassy field adjoining the bay in the summer of 1936. It has rarely been observed in the district since that year.

16. *Terias smilax* Donovan. Small Grass Yellow. Occasional stragglers are sometimes captured in the garden as they flutter about patches of long grass.

Family Danaidae. Milk-weed Butterflies.

17. *Danaus plexippus* L. Wanderer, Monarch. Prevalent during late summer and autumn. The larvae and pupae are to be found on the Wild Cotton, they may also be searched for on other plants and grasses growing in the vicinity of the food-plant.

18. *Danaus chrysippus petilia* Stoll. Lesser Wanderer. One observation only.

19. *Danaus melissa hamata* Macleay. Blue-spotted Wanderer. A male in fairly good condition of this visitor from the North was captured in my garden on 7th November, 1959.

20. *Euploea corinna corinna* Macleay. Common Crow. Periodically Common Crows invade the Sydney district and their bright golden chrysalids found attached to Oleanders seem to attract the attention and comment of many people. I have also found the caterpillars thriving on the vine known as *Mandevilla suaveolens*. Although the Sydney "born" butterflies deposit eggs, and pupae arising from them, adorn the Oleanders at the end of autumn, they are apparently unable to survive the winter, and until another irruption of the species in the North again causes a southern invasion to occur, the butterfly is but seldom observed.

Family Nymphalidae. Nymphs and Emperors.

21. *Hypolimnas bolina nerina* Fabricius. The Royal Emperor. Until the summer of 1955, this very fine butterfly was rarely observed in the districts under discussion.

22. *Eriboea pyrrhus sempronius* Fabricius. Tailed Emperor. Several specimens observed each autumn; but as it is a high and fast flier, it is difficult to capture on the wing. Like other members of the Nymphalidae, however, Tailed Emperors, are attracted to fermenting fruit and I have netted specimens without any trouble as they sipped the juices of rotten Persimmons. I have also found a white sheet hung on a clothes line to be an effective attractant.

23. *Precis villida calybe* Godart. Meadow Argus. A common species, the caterpillars of which feed on Plantains and Snapdragons *(Antirrhinum)*.

24. *Pyrameis cardui kershawi* McCoy. Painted Lady. A pretty butterfly, differing from the one on the British list, which bears the same vernacular name, by possessing blue submarginal spots instead of black. The Australian race is also much smaller and brighter in coloration. In favourable seasons, Painted Ladies occur in thousands. The larvae feed on different kinds of Everlasting Daisies *(Helichrysum)* and allied plants.

25. *Vanessa itea* Fabricius. Australia Admiral. Specimens are observed on the wing during various months of the year. I have even noticed odd ones sporting about the garden on sunny days in mid-winter, which suggests that Admirals are hibernating butterflies.

Family Satyridae. Browns and Ringlets.

26. *Heteronympha merope merope* Fabricius. Common Brown. A few males are usually observed each summer frequenting gardens. The very different looking females, however, appear to be less catholic in their tastes and do not wander far from their native tree-shaded haunts. For this reason, the popular name of Wood Nymph has been given them by collectors.

27. *Hypocysta metirius* Butler. Common Ringlet. Occasional specimens recorded.

Family Lycaenidae. Blues, Coppers and Hairstreaks.

28. *Candalides absimilis* Felder. Pencilled Blue. Before the old manor house in Five Dock with its gardens containing Black Bean trees, food-plant of *C. absimilis*, was destroyed, this attractive butterfly was comparatively common. The species is nearly always attracted to the leaves of the Wistaria and *Pittosporum*.

29. *Candalides heathi heathi* Cox. Rayed Blue. Many years ago, this unobtrusive butterfly was fairly common in the grassy fields adjoining Iron Cove. I have always regarded *C. heathi* as a "good thing" and have never known it to wander from its breeding haunt, which more than likely is some quiet corner in a meadow. The last capture in the district was made by K. D. Fairy on 19th February, 1948.
30. *Nacaduba lineata* Murray. Hairy Lineblue. A female was observed at rest on a leaf of a Nectarine tree on March 5th, 1950. Unfortunately it flew off before I could get the net.
31. *Nacaduba biocellata* Felder. Double-spotted Lineblue. A male in fairly good condition was captured on 31st January, 1961. It was attending Marguerite daisies.
32. *Zizeeria labradus labradus* Godart. Common Grass-blue. Some years more common than others.
33. *Neolucia serpentata* Herrich-Schaeffer. Chequered Blue.
34. *Neolucia sulpitius sulpitius* Miskin. Saltpan Blue. Both these species are fairly common in areas fringing the bay, which are overgrown with the food-plant *(Salicornia).*
35. *Lampides boeticus damoetes* Fabricius. Long-tailed Blue. The first brood of this Blue makes its appearance in September. The larvae are to be found feeding on Dolichos and Lupins. It was extremely common during October, 1949, the species has not been observed in such large numbers since that year.
36. *Syntarucus plinius pseudocassius* Murray. Plumbago Blue. The stronghold of this little butterfly was the garden of the old manor-house in Five Dock, where it could be seen in hundreds during late summer, flying about the hedges of Plumbago, on which it breeds. This butterfly does not appear to wander far afield from its breeding haunts, as I have only ever taken one female in the adjoining suburb of Haberfield.

Family Hesperiidae. Skippers.

37. *Badamia exclamationis* Fabricius. One remarkable capture of this northern species at Buddleia on 21st March, 1958. (cf. "The Australian Zoologist," Vol. XII, page 351.)
38. *Toxidia peroni* Latreille. Dingy Garden Skipper. Common species greatly attracted to Buddleia flowers. I once observed this species "sporting" madly with a male Orange Palm Skipper. The larvae feed on common grasses.
39. *Taractrocera papyria papyria* Boisduval. White-marked Grass-Skipper. Occurs commonly on Rodd's Peninsula, the first brood making its appearance as early as August.
40. *Padraona flavovittata flavovittata* Latreille. Yellow-banded Skipper. A lover of grassy fields. It is still fairly abundant on Rodd's Peninsula and is an occasional visitor to my garden.
41. *Cephrenesaugiades sperthias* Felder. Orange Palm Skipper. A handsome and common garden species. I have often found the semi-transparent caterpillars feeding on palm fronds, from which I have bred out long series of perfect specimens.
42. *Astycus kreffti ancilla* Herrich-Schaeffer. Green Skipper. In days when hedgerows of Lantana bordered fields in Five Dock, this skipper was quite abundant; but nowadays it is never seen and it would appear that it has vacated the district altogether.

LOCATION OF SPECIMENS.

The specimens referred to in this paper are in the author's collection.

ACKNOWLEDGMENTS.

The author wishes to thank the following: D. K. McAlpine, Assistant Curator of Insects, Australian Museum, Sydney, for kindly granting permission to use the Museum's collections for the purpose of classifying material discussed in the present paper; Dr. I. F. B. Common, Principal Research Officer, Division of Entomology, C.S.I.R.O., Canberra, for identifying several species; Rev. Colin Burgess, Rector of St. Oswald's, Haberfield, for naming some of the plants mentioned in the text.

Observations on Some Australian Forest Insects

14. A Preliminary List of Insects Attacking *Pinus* spp. in New South Wales

By K. M. Moore.
(Forestry Commission of New South Wales.)

INTRODUCTION.

A comprehensive survey of the extent and intensity of attack by insects damaging *Pinus* spp. was commenced by entomologists of the Forestry Commission of New South Wales during October, 1960. As only limited information on insects attacking *Pinus* spp. in that State has been published, this list is presented as a record of current and potential insect pests, and as a basis for future investigations.

The purpose of the survey was primarily to determine the insects causing damage to exotic pines, rather than to present an extended list of insect species merely associated with them. Most of the species studied were reared through the immature stages to the adult stage, and aspects of their biology were examined as an essential preliminary to further investigations.

A detailed study of the biology of each species, and information concerning their ecological interactions is of primary importance because of the increasing areas planted to *Pinus* spp. Consequently, when the majority of insects actually attacking *Pinus* spp. are recorded, the association of other species of insects with these hosts will also be examined.

More detailed information which will assist in the field identification of these insect species will be published in future papers.

LIST OF INSECT SPECIES.

The number of insect species studied in these investigations, to July, 1963, is given under the respective Orders:—

COLEOPTERA (beetles)	18
COLLEMBOLA (springtails)	1
HEMIPTERA (sap-feeding bugs, scales)	13
ISOPTERA (termites)	3
LEPIDOPTERA (moths and butterflies)	38
ORTHOPTERA (phasmatids, tree crickets)	4
THYSANOPTERA (thrips)	3
Total species	80

Within the various Orders, the number of species in the relevant family is given:—

COLEOPTERA	
Anobiidae	1
Anthribidae	1
Cerambycidae	6
Curculionidae	8
Eumolpidae	1
Scolytidae	1
COLLEMBOLA	
Hypogastruridae	1
HEMIPTERA	
Adelgidae	1
Aphididae	2
Cicadellidae	2
Coccidae	3
Flatidae	1
Lygaeidae	1
Membracidae	1
Pseudococcidae	2
ISOPTERA	
Calotermitidae	1
Rhinotermitidae	2
LEPIDOPTERA	
Anthelidae	6
Arctiidae	3
Eupterotidae	1
Geometridae	1
Lymantriidae	4
Noctuidae	5
Notodontidae	1
Oecophoridae	5
Psychidae	6
Tortricidae	5
Xyloryctidae	1
ORTHOPTERA	
Eumasticidae	1
Phasmatidae	1
Tettigoniidae	2
THYSANOPTERA	
Thripidae	3

The following list gives the insect species, some of their host plants, damage, and details of the localities.

COLEOPTERA

Anobiidae.

Ernobius mollis (L.)

Host: *P. radiata.*
Damage: Under bark on timber scantlings, and in wood of logs and dead trees or branches when bark is retained.
Localities: Moss Vale (highlands) and Somersby (coastal).

Anthribidae

Araecerus bicristatus Blkb.

Hosts: *P. pinaster, P. radiata.*
Damage: Severe damage to male inflorescence, or under bark and in centre of shoot stems.
Locality: Somersby (coastal).

Cerambycidae

Arhopalus syriacus (Reitt.) (introduced sp.)

Host: *P. radiata.*
Damage: Under bark and in wood of logs.
Localities: Somersby and Sydney (coastal).

Athemistus aborigine Carter

Host: *P. ponderosa.*
Damage: Under bark and in wood of logs.
Locality: Hanging Rock State Forest (highlands).

Athemistus harrisoni Carter

Host: *P. ponderosa.*
Damage: Under bark and in wood of logs.
Locality: Hanging Rock State Forest (highlands).

Athemistus ? luciae Carter

Host: *P. ponderosa.*
Damage: Under bark and in wood of logs.
Locality: Hanging Rock State Forest (highlands).

Disterna lugubris Pascoe

Host: *P. radiata.*
Damage: Under bark and in wood of fire-killed trees.
Locality: Somersby (coastal).

Disterna plumifera Pascoe

Host: *P. radiata.*
Damage: Under bark and in wood of fire-killed trees.
Locality: Somersby (coastal).

Curculionidae

Aesiotes leucurus Pascoe

Hosts: *P. pinaster, P. radiata.*
Damage: In stumps and logs.
Locality: Somersby (coastal).

Aoplocnemis ? guttiger Pascoe

Host: *P. radiata.*
Damage: Moderate to heavy damage to foliage, by adults only.
Locality: Blackheath (highlands).

Aoplocnemis rufipes Boheman

Hosts: *P. patula, P. ponderosa, P. pseudostrobis* and *P. radiata.*
Damage: Damage as for *A. guttiger.*
Localities: Hanging Rock State Forest, Mt. Mitchell State Forest (highlands).

Chrysolophus spectabilis F.

Hosts: *Acacia* spp., *P. radiata.*
Damage: Slight damage to needle sheaths and foliage.
Locality: Somersby (coastal).

Euthyrrhinus meditabundus F.

Hosts: *P. halepensis, P. radiata* and numerous indigenous and exotic tree species.
Damage: Under bark and in wood of unthrifty trees.
Localities: Mittagong, Goulburn (highlands), Somersby (coastal).

Perperus languidus Er.

Host: *P. radiata.*
Damage: Damage as for *Aoplocnemis* spp.
Locality: Mt. Mitchell State Forest (highlands).

Perperus lateralis (Boisd.)

Hosts: *P. elliottii, P. radiata.*
Damage: Damage as for *Aoplocnemis* spp., but also to stems of young shoots where a clear, resinous exudation appears at the point of attack.
Localities: Kulnura (highlands) and Somersby (coastal).

Perperus melancholicus Boisd.

Host: *P. radiata.*
Damage: Damage as for *P. lateralis.*
Localities: Blackheath (highlands), Ourimbah State Forest (coastal).

Eumolpidae

Geloptera porosa Lea

Hosts: *P. radiata, Hakea gibbosa, H. teretifolia.*
Damage: Adults cut through bases of needles.
Locality: Somersby (coastal).

Scolytidae

Hylastes ater Payk.

Host: *P. radiata.*
Damage: Severe damage under bark on logs, and damage to stems of seedlings.
Locality: Widespread throughout southern highlands.

COLLEMBOLA

Hypogastruridae

Xenylla occidentalis Womersley

Host: *P. radiata.*
Damage: In large populations on young shoots, smaller twigs and branches; damage to trees not apparent.
Locality: Somersby (coastal).

HEMIPTERA

Adelgidae

Pineus near *orientalis*

Hosts: *P. durangensis, P. elliottii, P. montezumae, P. pinaster, P. pseudostrobis, P. radiata, P. taeda.*
Damage: Large populations on small branches, shoots and boles; mainly on small trees, but also on large, old trees; often associated with stunted growth probably caused by virus; apparently transported on nursery stock.

Localities: Widely distributed on coast, highlands and western slopes where *Pinus* spp. are grown.

Aphididae

Eulachnus sp.

Host: *P. taeda.*
Damage: Damage not evident.
Locality: Whiporee State Forest (highlands).

? *Eulachnus* sp.

Host: *Pinus* sp.
Damage: Damage not evident.
Locality: Bullahdelah (coastal).

Cicadellidae

Orosius argentatus (Evans)

Host: *P. radiata.*
Damage: Associated with "die-back" of young nursery stock.
Locality: Moss Vale (highlands).

(Typhlocybinae) Gen. et sp. nov.

Host: *P. radiata.*
Damage: Damage not apparent; on foliage.
Localities: Lisarow, Somersby (coastal).

Coccidae

Coccus hesperidum L.

Hosts: *P. pinaster, P. radiata.*
Damage: Severe damage to foliage, accompanied by thick deposits of sooty mould.
Localities: Mt. Topper State Forest (western slopes) and Ourimbah State Forest (coastal).

Lindingaspis rossi (Maskell)

Host: *P. pinaster.*
Damage: Heavy attack accompanied by yellowing of foliage.
Localities: Mt. Mitchell State Forest (highlands) and Somersby (coastal).

Phenacaspis eugeniae (Maskell)

Host: *P. radiata.*
Damage: Slight damage to foliage.
Locality: Somersby (coastal).

Flatidae

Siphanta acuta Walk.

Host: *P. radiata.*
Damage: Damage not apparent; on foliage.
Locality: Lisarow (coastal).

Lygaeidae

Nysius vinitor Bergr.

Host: *P. radiata.*
Damage: Associated with "die-back" of young nursery stock.
Locality: Moss Vale (highlands).

Membracidae

Acanthucus sp.

Host: *P. radiata.*
Damage: Damage not apparent; on foliage.
Locality: Somersby (coastal).

Pseudococcidae

Pseudococcus adonidum (L.)

Host: *P. radiata.*
Damage: Damage not apparent; on stem of small plants.
Localities: Lisarow, Somersby (coastal).

Pseudococcus gahani Green

Host: *P. radiata.*
Damage: Damage not apparent; on stem.
Locality: Somersby (coastal).

ISOPTERA

Rhinotermitidae

Coptotermes acinaciformis (Froggatt)

Host: *P. radiata.*
Damage: Severe attack in old stump.
Locality: Somersby (coastal).

Coptotermes lacteus (Froggatt)

Host: *P. radiata.*
Damage: Dead tree, killed by lightning strike.
Locality: Mt. Mitchell State Forest (highlands).

Calotermitidae

Porotermes adamsoni Froggatt

Host: *Pinus* sp.
Damage: To growing trees on poor site quality.
Locality: Banyabba State Forest (coastal).

LEPIDOPTERA

Anthelidae

Anthela excellens (Walk.)

Host: *P. radiata.*
Damage: Slight damage to foliage.
Locality: Somersby (coastal).

Anthela nicothoe (Boisd.)

Hosts: *Acacia* spp. and *P. radiata.*
Damage: Damage to foliage severe.
Localities: Widespread throughout highlands of N.S.W.

Anthela ocellata Walk.

Host: *P. radiata.*
Damage: Damage usually slight.
Locality: Somersby (coastal).

Anthela near *varia*

Host: *P. radiata.*
Damage: Usually slight damage to foliage.
Localities: Somersby and Sydney (coastal).

Chelepteryx felderi Turner

Host: *P. radiata.*
Damage: Usually slight damage to foliage.
Locality: Somersby (coastal).

Chenuala heliaspis (Meyr.)

Hosts: *P. engelmanii, P. patula, P. radiata* and *Eucalyptus* sp.
Damage: Slight to moderate damage to foliage.
Localities: Hanging Rock State Forest, Blayney (highlands).

Arctiidae

Asura cervicalis Walk.

Hosts: *Ficus rubiginosa, P. radiata.*
Damage: Slight damage to foliage, even though large numbers of larvae may occur, but defoliation of former species may occur.
Localities: Mt. Topper State Forest (highlands), Somersby and Sydney (coastal).

Palaeosia bicosta Walk.

Host: *P. radiata.*
Damage: Damage as for *A. cervicalis.*
Localities: Armidale State Forest (highlands), Somersby (coastal).

Palaeosia sp.

Host: *P. radiata.*
Damage: Damage to foliage not evident.
Localities: Widespread throughout highlands, also on coast.

Eupterotidae

Panacela lewinae (Lewin)

Hosts: Most *Angophora* and *Eucalyptus* spp.; *Acacia* spp.; *Exocarpus cupressiformis; P. patula, P. radiata; Syncarpia glomulifera* and numerous indigenous tree and plant species.
Damage: Damage often severe on indigenous spp., but light on large trees or heavy on small trees of *Pinus* spp.
Localities: Widespread throughout western slopes, coast and highlands.

Geometridae

Lophodes sinistraria Guen.

Hosts: *Cratageus* sp., *Lagerstroemia* sp., *P. elliottii, P. radiata.*
Damage: Damage to foliage slight.
Localities: Lisarow, Somersby (coastal).

Lymantriidae

Axiologa pura Lucas

Hosts: *Citrus* sp., *Eucalyptus saligna, P. radiata.*
Damage: Slight damage to foliage.
Localities: Lisarow, Somersby (coastal).

Oligeria hemicalla (Lower)

Host: *P. radiata.*
Damage: Slight damage to foliage.
Locality: Somersby (coastal).

Orgyia anartoides Walk.

Hosts: *P. radiata* and numerous indigenous tree spp. and cultivated plants.
Damage: Damage to foliage slight on larger trees, severe on small trees of *P. radiata.*
Localities: Widely distributed throughout coast and highlands.

Porthesia paradoxa Bh.

Hosts: *Cotoneaster* sp., *Lagerstroemia* sp., *P. radiata.*
Damage: Usually slight damage to foliage.
Localities: Lisarow, Somersby (coastal).

Noctuidae

Agrotis infusa (Boisd.)

Hosts: *P. radiata* and numerous cultivated plants.
Damage: Damage to foliage and to roots and bark of nursery stock; sometimes severe.
Localities: Blackheath, Sunny Corner State Forest (highlands).

Agrotis munda Walk.

Hosts: *P. radiata, Pseudotsuga menziesii.*
Damage: Severe damage to nursery stock.
Localities: Wingello State Forest (highlands), Glenfield (coastal).

Androdes hypochalcis Turner

Host: *P. radiata.*
Damage: Slight damage to foliage of young plants.
Locality: Lisarow (coastal).

Euxoa radians (Guen.)

Hosts: *P. radiata* and numerous cultivated plants.
Damage: Damage to roots and lower stems of nursery stock, sometimes severe.
Locality: Vulcan State Forest (highlands).

Heliothis punctigera Wallengr.

Host: *P. radiata.*
Damage: Damage to young nursery stock, severe.
Locality: Sydney (coastal).

Notodontidae

Teara variegata Walk.

Hosts: *Acacia* spp., *P. radiata, Hakea sericea.*
Damage: Slight to moderate damage to foliage.
Localities: Lisarow, Somersby (coastal).

Oecophoridae

Arachnographa micrastrella (Meyr.)

Hosts: *P. elliottii, P. pinaster, P. radiata.*
Damage: Damage to male inflorescence, and light to moderate damage to foliage.
Localities: Mangrove Mountain (highlands), Somersby and Sydney (coastal).

Barea consignatella Walk.

Hosts: *P. radiata* and numerous indigenous and exotic trees and shrubs.
Damage: Beneath bark of stumps and in damaged areas on trees and shrubs.
Localities: Lisarow, Somersby and Sydney (coastal).

Coesyra sp.

Host: *P. radiata.*
Damage: Attacks rotting foliage and grasses in crotches of larger trees.
Locality: Somersby (coastal).

Elaeonoma sp.

Host: *P. radiata.*
Damage: Beneath bark of stumps.
Locality: Somersby (coastal).

Tortricopsis semijunctella Walk.

Hosts: *P. radiata, Juniperus* sp.
Damage: As for *A. micrastrella* but larvae also bore in stems of young shoots.
Locality: Somersby, Sydney (coastal).

Psychidae

Clania tenuis Rosen.

Host: *P. radiata.*
Damage: Defoliation of small trees, moderate damage on larger trees.
Localities: Sydney and Newcastle (coastal).

Hyalarcta hubneri Westw.

Hosts: *P. ayacahuite, P. elliottii, P. radiata,* flowers of *Leptospermum minutifolium,* and numerous indigenous and exotic trees and shrubs.
Damage: Defoliation of small trees, moderate damage on larger trees.
Localities: Widely distributed throughout western slopes, coast and highlands.

Lepidoscia ? punctiferella (Walk.)

Host: *P. radiata.*
Damage: Slight damage to foliage.
Localities: Armidale State Forest (highlands), Somersby (coastal).

Narycia sp.

Hosts: *P. pinaster, P. radiata.*
Damage: Slight damage to foliage.
Localities: Mt. Topper State Forest (western slopes), Mt. Mitchell State Forest Armidale State Forest (highlands), Lisarow, Somersby (coastal).

Oiketicus elongatus Saund.

Hosts: *P. radiata,* and several indigenous and exotic trees and shrubs.
Damage: Moderate damage to foliage.
Localities: Lisarow, Newcastle and Sydney (coastal).

Trigonocyttara clandestina Turner

Hosts: *P. radiata,* most *Eucalyptus* spp. and numerous indigenous and exotic trees and shrubs.
Damage: Damage to foliage severe on small trees, moderate on larger trees.
Localities: Mt. Topper State Forest (western slopes), Mt. Mitchell State Forest and Armidale State Forest (highlands), Lisarow, Somersby and Sydney (coastal).

Tortricidae

Acropolitis rudisana (Walk.)

Hosts: *Pinus* spp.
Damage: Severe to nursery stock.
Localities: Mt. Mitchell State Forest (highlands), Sydney (coastal).

Cryptoptila immersana (Walk.)

Host: *Pinus* spp.
Damage: Severe damage to nursery stock.
Locality: Sydney (coastal).

Epiphyas postvittana (Walk.)

Hosts: *P. radiata,* cultivated apple and rose, and numerous indigenous and exotic shrubs.
Damage: Damage to foliage slight on young tips of *P. radiata.*
Localities: Lisarow, Somersby (coastal).

Epiphyas xylodes (Meyr.)

Host: *P. radiata.*
Damage: Damage similar to that of *E. postvittana.*
Locality: Blackheath (highlands).

Isotenes miserana (Walk.)

Hosts: *P. radiata, P. elliottii* and *Cedrela australis.*
Damage: Damage similar to two previous species.
Localities: Lisarow, Ourimbah State Forest, Pennant Hills (coastal).

Xyloryctidae

Plectophila discalis Walk.

Host: *P. radiata.*
Damage: Damage similar to that of *A. micrastrella.*
Localities: Lisarow, Somersby (coastal).

ORTHOPTERA

Eumasticidae

Moraba amiculi Sjost.

Host: *P. radiata.*
Damage: Slight damage to foliage.
Locality: Somersby (coastal).

Phasmatidae

Ctenomorpha sp.

Host: *P. radiata.*
Damage: Slight damage to foliage.
Locality: Somersby (coastal).

Tettigoniidae

Caedicia sp.

Host: *P. radiata.*
Damage: Destroys unopened tips of foliage on young plants.
Locality: Mt. Mitchell State Forest (highlands).

Phaneropterinae gen. et sp. indet.

Host: *P. radiata.*
Damage: Bases of needles damaged.
Locality: Somersby (coastal).

THYSANOPTERA

Thripidae

Heliothrips haemorrhoidalis Bouche

Host: *P. radiata.*
Damage: Damage sometimes severe, causing yellowing and silvering of foliage, with mortalities of lower branches on unpruned trees and of small plants. Occurs in large numbers in open situations during cooler weather, or in shaded situations during summer.
Localities: Lisarow, Somersby (coastal).

(two unidentified spp.)

Host: *P. radiata.*
Damage: In small numbers on young shoots. Damage not evident.
Locality: Lisarow (coastal).

CONCLUSION

From observations, collections and biological studies of these insects attacking *Pinus* spp. it appears that:—

(a) *P. radiata* is much more consistently and heavily attacked than any other *Pinus* sp. in New South Wales, even when the much greater area planted to this species is considered.

(b) Most of the insect species attacking *Pinus* spp. have the common characteristic of feeding on a wide range of host-species in the field. This appears to enable them to feed on exotic plant spp. quite readily. Conversely, when an indigenous insect is host-specific, or almost so, this characteristic is apparently absent.

(c) *Pinus* spp. growing on prime quality sites show little or no attack, while heaviest attack appears to occur on the lower quality sites and/or untreated stands.

ACKNOWLEDGMENTS

The writer is grateful to the following for identifications of the insect species dealt with in this paper:—

Australian Museum: Dr. J. W. Evans, Messrs. D. K. McAlpine and C. N. Smithers.

British Museum: Drs. V. F. Eastop, M. S. K. Ghauri, P. M. Newman, B. J. Selman; Messrs. E. A. J. Duffy and R. D. Pope.

C.S.I.R.O. (Canberra): Dr. K. H. L. Key; Messrs. I. F. B. Common and E. Reed.

Department of Argiculture, N.S.W.: Messrs. M. Casimir and P. C. Hely.

Department of Agriculture & Stock, Queensland: Dr. A. R. Brimblecombe.

Forestry Commission of N.S.W.: Mr. P. Hadlington.

South Australian Museum: Mr. A. Womersley.

Waite Agricultural Research Institute (Sth. Aust.): Miss H. M. Brookes.

CORRIGENDUM.

In the last Proceedings of the Society for 1958-9 (28 February 1961), under "Observations on Some Australian Forest Insects. No. 6," on page 88, the sentence "Spherical, red and yellow galls are formed on leaves by another species of psyllid," should have been deleted.

Obituary

LUDWIG GLAUERT, M.B.E., B.A., F.G.S., F.R.Z.S.

The death in Perth, Western Australia, of Mr. Ludwig Glauert early this year (February 1st, 1963) removed an eminent and well-loved figure from the Western Australian scientific world, a fine old naturalist of a type impossible to replace in the modern age of scientific specialists. Mr. Glauert has been a member of the Royal Zoological Society of New South Wales since 1944, was elected a Fellow and made an Honorary Life Associate Member

Mr. Glauert was born in Sheffield, England, on 5th May 1879. He came to Western Australia in 1908, engaged in geological field work there, and became a scientific assistant at the Museum in Perth in 1910. He served overseas in the Australian Imperial Forces in the First World War, lectured in A.I.F. depots in the United Kingdom after the Armistice, and studied at the British Museum and the Royal College of Surgeons, returning to Western Australia in 1920. His early interests were in the field of geology and petrology but he had an extraordinarily wide knowledge of practically all groups of animals and plants and was the centre of appeal for biological information from the length and breadth of Western Australia. The name of Mr. Glauert was as familiar in outback stations as it was in the towns of that huge State and so specimens arrived in a steady stream in the Western Australian Museum of which Glauert became Curator in 1927. He attended to practically all museum details personally, preserving, registering, cataloguing and acknowledging thousands of miscellaneous donations and although busy, would spare time for any caller who showed genuine interest in natural history. He spoke fluent German and was widely read in several languages. He was a staunch conservationist and an engaging lecturer and broadcaster. The University of Western Australia conferred on him the degree of Bachelor of Arts in 1928.

In 1945, Glauert was awarded the Kelvin Medal by the Royal Society of Western Australia, of which he was twice President. He retired from directing the Western Australian Museum in 1956 and the *Western Australian Naturalist* paid him the deserved tribute of a special valedictory issue of its publication. He received the honour of Membership of the British Empire from H.M. Queen Elizabeth II in the New Year's Honours for 1960.

Genera of Amphibia, Siphonaptera and Pisces were named after Glauert and many species of various animal groups. Glauert found time to write papers and books on geology, palaeontology, insects, arachnida (especially scorpions), crustacea, amphibia, reptiles, whales and other matters. He was correcting the typescript of a check-list of scorpions in hospital not long before he died.

Biographical notices of Glauert have appeared in the *Daily News* (Perth, W.A.) 10 Dec. 1928; *The Naturalist* October, 1933: 239; *J. Roy. Soc. W. Austr.* 31, 1948, p. vi & portrait; *Austr. J. Sci.* 19 (3), 1956: 112 and, with a bibliography and portraits, in the *Western Australian Naturalist* 5 (7), 1957, valedictory number in honour of Ludwig Glauert: 146-165. Dr. D. L. Serventy supplies further information in the *Western Australian Naturalist* 8 (8), 1963: 189-193, with portraits, and in the *Emu* 63, 1963: 74-75.

—G. P. WHITLEY.

Recommendations for Authors

These recommendations have been drawn up for the guidance of authors wishing to submit papers for publication in the "Australian Zoologist"; adherence to these recommendations will facilitate the consideration of papers and their passage through the Press.

GENERAL RULES.

Manuscripts should be typewritten, in double spacing, on foolscap paper, on one side of the page only, and with a margin of at least one inch on the leading side, top and bottom of each page. The original should be submitted and a copy retained by the author at least until the paper has been published. Manuscripts should be complete in all details and accompanied by necessary drawings and/or photographs, numbered and arranged for block-making. Text, references and illustrations should be thoroughly checked before submission. Only generic, specific and subspecific names, and other words to be printed in *italics* should be underlined. Higher categories (e.g. Families, Orders) are not printed in italics and should not be underlined but should start with a capital letter. Papers should be as concise as possible consistent with adequate presentation; the inclusion of irrelevant matter which does not add to the informative content of the paper should be avoided. Pages should be numbered consecutively throughout the paper.

PREPARATION OF MANUSCRIPT.

All zoological papers must conform with the "International Code of Zoological Nomenclature." *Titles* of papers should be as brief as possible, but should indicate *clearly* the nature of the communication to enable the reader to determine immediately the special group and/or subject being dealt with in the text. The title should be typed on the first page of the manuscript. When a title refers to a group in the animal kingdom, this information should include at least two names, usually those of the order and family, e.g. "A Taxonomic Revision of American Leafhoppers (Homoptera, Cicadellidae)." The *author's name* should appear immediately after the title, centred, and be followed below by a concise but usable form of address. *Headings* for all taxonomic categories from subspecies upwards should be centred. In general, main headings should be centred, lesser headings being placed either at the left margin or run on. A full stop should be used only after unbracketed numerals in the headings. *Spelling and punctuation* should be those used in "The Concise Oxford Dictionary." Uniformity should be observed in capitalization, hyphenation and punctuation. As far as possible, commonly adopted *abbreviations* should be used. Dates, when used in the text, should be written—for example—as 2 January, 1903, but in tables and lists of specimens as 2. i. 1903. (Authors should consult the C.S.I.R.O. "Guide to Authors," Appendix I, Melbourne, 1953, for a list of abbreviations and symbols.) All *measurements* should, normally, be given in the metric system. When numbers are included in the text, they should be written out. *Footnotes* should not be used unless absolutely necessary. They should be inserted in the text following the line containing the word or sentence to which the footnote refers, and ruled off above and below. They should be numbered consecutively. *Tables* should be typed on separate sheets, numbered consecutively, and provided with distinctive titles. Approximate positions for insertion of tables should be indicated in the manuscript by leaving a blank space, typing in number and title of the table and leaving another blank space. *References* should be

collected in a list at the end of the paper under the heading "References." They should be arranged in alphabetical order, each giving: Name(s) followed by initial(s) of author(s); year of *publication;* title of paper; journal's title abbreviated in accordance with the "World List of Periodicals" and underlined (Note that abbreviation for Journal is J.); volume number in arabic numerals, without the prefix "vol."; the numbers of the pages, without the prefix "P."; indication of figures and Plates; references will appear in the following form: Beadle, L. C., 1931. The effect of salinity changes in the water contents and respiration of marine invertebrates. *J. exp. Biol.* 8: 211-227, 4 figs. If several papers by the same author in one year are cited, *a, b, c* are placed after the years of publication, thus: Pearman, J. V., 1932a. Notes on the genus *Psocus* with special reference to the British species. *Ent. mon. Mag.* 68: 193-204. Pearman, J. V., 1932b. Some coccophagous Psocids (Psocoptera) from East Africa. *Stylops* 1: 90-96. In citing papers in the text from the list of references, the name of the author and the year of publication are placed in brackets, or the page and figure numbers may be included, thus: "(Brown, 1954) or (Brown 1954: 25, fig. 4) or Brown (1954: 25) stated . . ." It is desirable that a *summary* should be presented at the beginning of the text, headed as such. This summary should convey briefly the contents of the paper and draw attention to new information and to the main conclusions. It should be written concisely, preferably in the third person and, in general, should not exceed 250-300 words. It should be intelligible in itself without reference to the paper. In taxonomic papers reference should be made to new genera and species described unless there are excessively large numbers of such involved.

ILLUSTRATION.

Only illustrations essential to its elucidation should be included in a paper. Illustrations should preferably be in the form of *line-drawings* wherever possible. Each figure or plate should be clearly marked on the back with the author's name and the title of the paper to which it belongs. *Plates:* The normal size when reduced (if intended for reduction) should not exceed that of the type area of a page in "The Australian Zoologist." When several illustrations are to be included on one plate they should be of such size and shape to admit of reduction without loss of detail and legibility. They should be numbered or lettered for reference. Numbers or symbols which are to appear as part of a plate must be neatly executed, *proportionately,* in India ink, or, on a very dark background, Chinese white. A number of small photographs (rectangular rather than circular) should be assembled to form one plate, mounted on stiff white paper or cardboard. The photographs should show good contrast and be printed on glossy paper. *Line drawings:* These will include diagrams, graphs, maps etc. They should be drawn in India ink on smooth white paper, Bristol board or tracing linen. When it is not desired to reproduce the squares of the paper on which graphs have been drawn, paper ruled in light blue lines should be used. When text figures are to appear as a full page illustration allowance must be made for the caption which will appear underneath; figures *and* caption must fit into page size. Where possible line drawings should be grouped to fill a page. Approximate positions for the insertion of the line drawings in the text should be indicated as for tables. *Maps* should be drawn so as to economize space as far as possible and, in general, the title should not be included in the map but written underneath for type-setting. If plates or text-figures have been prepared for reduction the amount of reduction should be clearly indicated. Suggestions are: to draw a line AB on the margin of the illustration, indicating the amount of reduction by cutting off a segment AC, the appropriate fraction of AB, and adding a note "reduce AB to AC"; or, to indicate on the drawings the required width of the block, e.g. thus: ←——— 4″ ———→. Illustrations for inclusion in the text should be drawn approximately twice the width at which they are to be reduced in the text. Each separate figure should be clearly numbered, and lettering, etc., should be plain and large enough to be clearly readable when

reduced. Text-figures and plates should be numbered consecutively and referred to in the text by number. *Legends* to all figures and plates should be included on a separate sheet or sheets with the manuscript.

Illustrations and manuscript should be mailed or delivered *flat* to: The Honorary Secretary, Royal Zoological Society of New South Wales, Bull's Chambers, Martin Place, Sydney. They should never be bound or rolled. Originals of illustrations should be submitted.

REPRINTS.

Individual authors receive 25 copies of each paper free of charge (joint authors share this number). Additional copies may be ordered provided that the number of such copies is indicated *when the proofs are returned.*

ACCEPTANCE OF PAPERS.

Papers will be considered by the Editorial Committee and may be submitted to referees for comment before acceptance. Papers for publication should not be offered to other journals and should not have been previously published. Manuscripts which are not assembled and presented in conformity with these recommendations may be returned to the author for alteration; adherence to these recommendations will, therefore, facilitate publication. Authors must accept responsibility for the accuracy of their facts, the opinions they express and for adherence to the International Code of Zoological Nomenclature. Every care will be taken of manuscripts and drawings but the Society cannot take responsibility for loss or damage.

CORRECTION OF PROOFS.

The address to which proofs are to be sent for correction should be indicated when the manuscript is submitted. Proofs should be corrected and returned promptly to the Editor. As manuscripts submitted for publication should be in a form ready for despatch to the printer, proofs are sent to authors for the correction of printer's errors only. Where an author makes any other alteration to proofs it may be necessary to charge for same.

Fig. 1. Defoliation of *Angophora floribunda* by *Panacela lewinae*.
Photo. Ross Moore.

Fig. 2. Early stage of bag-shelter and damage by *P. lewinae*.
Photo. K. G. Campbell.

Fig. 3. Bag shelter of last instar larvae of *P. lewinae*.
Photo. Ross Moore.

Fig. 4. Adult males (right) and females (left) of *P. lewinae*.
Photo: P. Hadlington.

Brown Honey-eater, *Gliciphila indistincta,* at nest. Photo: N. Chaffer.

Golden-headed Fantail Warbler, *Cisticola exilis, at nest.* Photo: K. A. Hindwood.

Little Grassbird, *Megalurus gramineus*, at nest. Photo: N. Chaffer.

Views of Canada Bay Swamp. Photos: K. A. Hindwood.

Above: View of Canada Bay Swamp.

Below: Haunt of the Golden-headed Fantail Warbler, *Cisticola exilis.* Photos: K. Hindwood.

Reed Warbler, *Acrocephalis australis* at nest. Photo: R. Cooper.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

MEMBERSHIP.

(The Society's year commences on 1st July)

Fees commencing 1st July 1952 as follows:

Class	*Amount of Subscription*
Associate Member	£1 1 0 per annum
Ordinary Member	£2 2 0 " "
(Members joining after 1st January in any year pay one-half subscription.)	
Life Associate Member	£10 10 0 in one sum
Life Member	£21 0 0 " " "
Honorary Member	Elected for services to Australian Zoology or to the Society
Honorary Associate Member	Elected for services to Australian Zoology or to the Society
Junior Members (aged 16 or under)	5 0 per annum

TITLES.

(Conferred by the Council)

Fellow	For valuable services to the Society or to Australian Zoology
Associate Benefactor	For contribution of £100 to the Society's Funds
Benefactor	" " £500 " " " "
Endowment Member	" " £1,000 " " " "

PRIVILEGES.

Members of all classes may attend all meetings of the Society and its various Sections. Every member (other than an Associate or Life Associate Member) receives a free pass to Taronga Zoological Park and Aquarium, and twelve tickets each year, admitting 12 adults or 24 children to the Park only.

APPLICATION FOR MEMBERSHIP

should be addressed to the Honorary Secretary, Royal Zoological Society of New South Wales, 28 Martin Place, Sydney.

PUBLICATIONS

"The Australian Zoologist," published at irregular intervals since 1914. Twelve volumes to date.

"Proceedings," published annually since 1933-34.

AUSTRALIAN ZOOOGICAL HANDBOOKS AND SPECIAL REPRINTS.

"Bibliography of Australian Entomology, 1775-1930," by A. Musgrave, 1932.

"Australian Insects," by K. C. McKeown, 1947.

"A Check List of the Birds of Paradise and Bower Birds," by T. Iredale, 1948.

"Revision of the New South Wales Turridae," by C. F. Laseron, 1954.

"The Published Writings of Tom Iredale, with an Index of his new Scientific Names," by D. F. McMichael & G. P. Whitley, 1956.

"A Reclassification of the Order Odonata," by F. C. Fraser, 1957.

"Dragonflies of Australia," by F. C. Fraser, 1960.

Orders and enquiries should be sent to the Honorary Secretary, Royal Zoological Society of New South Wales, 28 Martin Place, Sydney.

CONTENTS OF THIS PART

Wholly set up and printed in Australia for the Royal Zoological Society of N.S.W., by E. J. Miller & Co., 11 Fotheringham Lane, Marrickville

THE

AUSTRALIAN ZOOLOGIST

Issued by the

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

Volume XIII — Part 2

August 10, 1965

Price £1
Two Dollars

All communications to be addressed to the Hon. Secretary,
Royal Zoological Society of New South Wales,
28 Martin Place, Sydney.

Registered at the G.P.O., Sydney, for transmission by post as a periodical.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

Established 1879

REGISTERED UNDER THE COMPANIES ACT 1899 (1917)

Patron:

His Excellency Lieutenant-General Sir Eric Woodward, K.C.M.G., C.B., C.B.E., D.S.O., Governor of New South Wales.

Vice-Patrons:

Sir Edward Hallstrom, K.B., F.R.Z.S.
Aubrey Halloran, O.B.E., B.A., Ll.B., Ll.D., F.R.Z.S.

COUNCIL, 1964-65

President:

John Cameron Yaldwyn, M.Sc., Ph.D.

Vice-Presidents:

Henry John de Suffren Disney, M.A.
Ernest Jeffrey Gadsden, F.R.Z.S.
Lawrence Courtney-Haines, A.Mus.A., L.T.C.L.
Gilbert Percy Whitley, F.R.Z.S., R.A.O.U.

Honorary Secretary: Mrs. Leone Harford.

Honorary Editor: Gilbert Percy Whitley, F.R.Z.S., R.A.O.U.

Honorary Treasurer: John Leonard Fry.

Members of Council:

John Miles Campbell
Henry John de Suffren Disney
John Leonard Fry
Ernest Jeffrey Gadsden
Maxwell Hall Gregg
Lawrence Courtney-Haines
John Hallstrom
Claude Hardy
Mrs. Leone Harford
Frank McCamley
Basil Joseph Guy Marlow, B.Sc. (Hons. Lond.), F.Z.S.
Anthony Irwin Ormsby, Ll.B.
Peter Edward Roberts
Frank Hamilton Talbot, M.Sc., Ph.D.
Ellis le Geyt Troughton, F.R.Z.S., C.M.Z.S.
Gilbert Percy Whitley
Mrs. Olive Wills
John Cameron Yaldwyn

OFFICERS:

Honorary Solicitor: Aubrey Halloran, O.B.E., B.A., Ll.B., Ll.D., F.R.Z.S.

Honorary Auditors: Messrs. Peat, Marwich, Mitchell and Company.

Honorary Librarian: Mrs. Leone Harford.

Assistant Honorary Secretary: Mrs. Olive Wills.

Assistant Honorary Treasurer: (Vacant).

OFFICERS OF SECTIONS.

Entomological Section:
Chairman: Mr. M. Gregg.
Hon. Secretary: Mrs. V. Gregg.

Conchological Section:
Chairman: Mr. F. McCamley.
Hon. Secretary: Mrs. O. Wills.

Junior Group:
Chairman: Mrs. L. Harford.

Ornithological Section:
Chairman: Mr. L. C. Haines.
Hon. Secretary: Mr. H. Battam.

THE AUSTRALIAN ZOOLOGIST

VOLUME XIII PART 2

THE "SYDNEY" BIRD PAINTINGS

By K. A. Hindwood

(Plates viii-ix)

The visit of Captain Cook, and the naturalists Banks and Solander, to eastern Australia in the *Endeavour* in 1770 revealed a new and fascinating world in the domain of the natural sciences. The observations of these eminent men, and the collections they gathered, not only in Australia but in various parts of the Pacific, aroused widespread interest in England and Europe. Thus, when Sydney Cove was settled some 18 years later numerous specimens of birds and other animals, insects, shells, shrubs and native implements were sent "Home" to scientists and dilettanti alike by the pioneers of "Botany Bay."

Books, such as those of Phillip (1789), White (1790) and Hunter (1793), gave prominence to the natural history of Sydney and its surroundings: but apart from published works, there is, in the form of diaries, letters, and especially drawings, much that is of great interest to naturalists.

Most of this material is known to historians and has been discussed over the years: nevertheless, there is still a lot to be done in the way of assessing its historical worth. This is especially so in the case of the many natural history paintings which, for the most part, now repose in libraries and museums in various parts of the world.

Some of the better-known drawings are the "Watling" series, named after the convict-artist Thomas Watling; the "Lambert" series, once in the possession of A. B. Lambert, a prominent botanist of his day, and the "Raper" paintings which have recently (Hindwood, 1964) been discussed in detail.

Another collection worthy of attention is that of 100 (originally 101) watercolour drawings of birds purchased by the Trustees of the Public Library of New South Wales in 1887 from a London bookseller and now housed in the Mitchell Library, Sydney. These drawings are on separate sheets tipped in to a bound volume and are, in the main, skilfully executed by several unknown artists. The sheets vary in size from quarto to folio.

Generally the artists have given brief details such as the scale of the figure, the colour of the iris of the bird, and the month in which the painting was done, but only in two instances has the year been stated. In addition, brief notes on habits or plumage are given on a number of the drawings, and the pencilled handwriting, in some cases, appears to be that of Captain Arthur Phillip, the first Governor of the Colony, a supposition I discussed in 1933 (Hindwood, 1933).

It is known that Phillip sent natural history drawings to Sir Joseph Banks and doubtless also to other naturalists in England: thus it is possible that the present series was assembled by Phillip for a friend in England, or even for his own pleasure. A few months before his death, in August 1814, Phillip prepared a will wherein he specifically mentions drawings made in

New South Wales and which he ordered to be sold immediately after his death (Mackaness, 1937). There is a strong inference in the above circumstances that the 100 drawings now in the Mitchell Library were at one time in the possession of Phillip.

The earliest mention, in Australian literature, of this historically important collection appears to be a note by A. J. Campbell. In discussing (Campbell, 1912) Edward Augustus Petherick's manuscript bibliography of Australiana based largely on material presented by Petherick to the Commonweath Parliamentary Library, Campbell states:

> 1791-2. The Bibliographer notes there are in the Sydney Public Library 101 beautifully coloured drawings of birds, chiefly from Norfolk Island, of this date . . ."

Certainly some Norfolk Island species are represented in the series, but most of the drawings are of birds found near Sydney.

The bound volume containing the paintings is titled on the spine in gold, "Drawings of Birds Chiefly from Australia", and a cutting from a bookseller's catalogue, pasted on the verso of the fly-leaf, reads:

> Drawings of birds chiefly from Australia. A collection of 101 beautifully coloured drawings, with descriptions in pencil. El. fol. N.P. 1791-2.

The drawings were transferred to the Mitchell Library (a specialised section of the Public Library) in August 1929. Earlier in that year I happened to come upon a reference to the drawings in the old printed catalogue of the Public Library. A brief scrutiny of the collection indicated that their historical worth was considerable, and therefore Tom Iredale (at the time on the staff of the Australian Museum), who had worked over the "Watling", "Lambert" and other drawings in England with Gregory Mathews during the preparation of the *Birds of Australia* (1910-27), was asked to examine the series. He realised at once that they were a contemporary set and that, in many instances, the styles of painting closely resembled, or perhaps were the same as, some of the drawings in the "Watling" collection in the British Museum (Natural History).

Subseqeuently (Hindwood, 1931) these drawings were called the "Sydney" set, a fitting name because most of them were done at Port Jackson during the first years of settlement and then, after an absence of almost 100 years, were returned to Sydney in 1887. In the interim they had obviously passed through several hands because as many as five different writings are on some of the sheets.

The birds depicted are largely species still frequenting the Sydney district. However, certain kinds—the Red-backed Wren (33), Glossy Black Cockatoo (48), Ground Parrot (50), Pied Oyster-catcher (87) and Pied Goose (98)—no longer occur in the area, and others—the Grey Currawong (15), Blue-faced Honeyeater (56) and Diamond Dove (80)—may be classed as rare vagrants or stragglers. One of the paintings (32) is a well-drawn figure of a flycatcher-like bird that does not resemble any known species.

Eleven sheets (24, 26, 29, 30, 31, 84, 96, 97, 99, 100, 101), representing seven species, are of birds from Norfolk Island, one of which (84) is of the extinct Norfolk Island Pigeon; another (96) is of a dove-petrel and was until recently only known evidence of such a species.

The colours of the paintings, even after the lapse of more than 170 years, still appear fresh and true. Slight changes have taken place in some instances, as where a white body-colour has been laid over a dark ground: through absorption the white has changed to a bluish shade. Otherwise, however, the colours are, with few exceptions, remarkably accurate.

Two sheets (46, 71) each have three figures on them: five sheets (4, 17, 26, 34, 72) each depict two birds, sometimes the male and female of a species, or else two distinct species: the rest of the drawings are of single birds. Where

the same species is present more than once in the series the additional paintings are by different artists.

The numbers preceding the identifications refer to the order in which the paintings appear in the bound volume.

1. Black-shouldered Kite, *Elanus notatus*.
"August. Natural Size."
The figure agrees best with the above species, which is not uncommon near Sydney, whereas the closely-related Letter-winged Kite, *E. scriptus*, is exceedingly rare in coastal New South Wales.

2. Missing from volume.
A faint imprint on the reverse of the first folio shows that the bird depicted had a distinct facial-disc, a dark back and light underparts, indicating either the Barn Owl, *Tyto alba*, or the Masked Owl, *T. novaehollandiae*.

3. Ground Thrush, *Zoothera lunulata*.
"August — Natural size."

4. Spotted Quail-Thrush, *Cinclosoma punctatum*, male and female. "Drawn the natural size being the only two of the kind (as yet) seen on the Colony — June 1792."
The last four words and the year have been repeated. The Spotted Quail-Thrush was first described and figured in Shaw's *Zoology of New Holland* (1794).

5. Olive-backed Oriole, *Oriolus sagittatus*.
"Natural size, July — Iris doubtful."

6. Black-backed Magpie, *Gymnorhina tibicen*.
"May. Natural size."

7. Black-backed Magpie, *G. tibicen*.
"April. ½ the Natural size — This bird has a very uncommon and not unpleasant note."

8. Dollar-bird, *Eurystomus orientalis*.
"October. Reduced to half the size of the Bird the Drawing was taken from."

9. Grey Butcher-bird, *Cracticus torquatus*, female plumage.
"July — Natural size."

10. Grey Butcher-bird, *C. torquatus*, male plumage.
"Natural size — Iris doubtful."

11. Eastern Shrike-tit, *Falcunculus frontatus*, male.
"October, Natural size."

12. Dusky Wood-Swallow, *Artamus cyanopterus*.
"April — Natural size."

13. White-browed Wood-Swallow, *A. superciliosus*, male.
"December — Natural size."

14. Little Cuckoo-Shrike, *Coracina robusta*, immature.
"August — Natural size."

15. Grey Currawong, *Strepera versicolor*.
"½ the Natural size."

16. Grey Shrike-Thrush, *Colluricincla harmonica*.
"The same size as the bird the drawing was taken from. April."

17. Eastern Striated Pardalote, *Pardalotus ornatus*.
Spotted Pardalote, *P. punctatus*, female.
"August. Both drawn Natural size and supposed to be of a different kind. Natural size."

18. Golden Whistler, *Pachycephala pectoralis*, male.
"Natural size."

19. Golden Whistler, *P. pectoralis,* male.
"April — Natural size."

20. Golden Whistler, *P. pectoralis,* male.
"April — Natural size."
The above three drawings are by different artists who seem to have used the same specimen as a model.

21. Restless Flycatcher, *Seisura inquieta.*
"June — Natural size."

22. White-shouldered Caterpillar-eater, *Lalage sueurii,* male.
"November — Natural size."

23. Brown Tree-creeper, *Climacterus picumnus.*
"May, Natural size — Iris and Tongue doubtful."

24. Scarlet Robin, *Petroica multicolor,* male.
"Natural size."
The figure represents the form of the Scarlet Robin living on Norfolk Island, which place is the type locality of the species. Drawings Nos. 29. 30 and 31, all of Norfolk Island birds, are also by the same artist, whose work is lacking in finish when compared with most of the other paintings in the series.

25. Scarlet Robin, *P. multicolor,* male.
"Car-ral, gan, yei, sar. Natural size."
A painting of the form, i.e. *boodang,* occurring in New South Wales.

26. Scarlet Robin, *P. multicolor,* female.
Scarlet Robin, *P. multicolor,* male.
"Two Birds of Norfolk Island (Natural size)."

27. Hooded Robin, *Melanodryas cucullata,* female.
"May, Natural size."

28. Willie Wagtail, *Rhipidura leucophrys.*
"July — Natural Size."

29. Norfolk Island Blackbird, *Aplonis fuscus,* male.
"Blackbird."

30. Norfolk Island Blackbird, *A. fuscus,* female.

31. Slender-billed White-eye, *Nesozosterops tenuirostris.*

32. Indeterminable.
"July — Natural size."
The bird figured is the same as that in "Lambert" drawing No. 12, (vol. 2) and "Watling" drawing No. 180 which Bowdler Sharpe states (1906) is the Black-cheeked Flycatcher, *Muscicapa barbata* of Latham (1801), and which he says is the Yellow-throated Scrub-Wren, *Sericornis lathami.* However, the three drawings, all similar in posture and colouring, but by different artists, are not of that species and do not represent any known Australian bird.
The bill is dark brown and slender; the forehead white, spotted black; the entire under-surface is white with a lemon wash on the breast; the crown and sides of the face are blackish, with a broad yellow stripe extending through and behind the eye; the back and wing-coverts are brown, the primaries being darker; the wing shows a pale yellow central bar; the upper tail-coverts are reddish, the tail itself being long and brown, paler near the tip. Total length of the figure is 130 mm., culmen 8 mm., tarsus 17 mm., wing 45 mm., tail 55 mm.

33. Red-backed Wren, *Malurus melanocephalus,* Male.
"Natural size."
This species is figured in several collections of drawings made during the early years of settlement. It has not since been observed in the Sydney district. The present southern limit of distribution in New South Wales appears to be the Taree area, some 150 miles north of Sydney (see Hindwood, 1964, p. 44).

34. Superb Blue Wren, *M. cyaneus,* female.
Superb Blue Wren, *M. cyaneus,* male.
"Mo-ro, dru, ing — Male and Female — Natural size."

35. Emu-Wren, *Stipiturus malachurus,* male.
"Natural size."

36. Little Thornbill, *Acanthiza nana.*
"September — Natural size."

37. Little Thornbill, *A. nana.*
"October — Natural size."

38. Pipit, *Anthus australis.*
"July — Natural size."

39. Speckled Warbler, *Chthonicola sagittata.*
"July — Natural size the notes of this bird are equal if not superior to the English Linnet."

40. Red-browed Finch, *Aegintha temporalis.*
"Natural size."

41. Diamond Firetail, *Zonaeginthus guttatus,* immature.
"June — Natural size Iris doubtful."

42. Beautiful Firetail, *Z. bellus.*
"Natural size."

43. Diamond Firetail, *Z. guttatus.*
"February, Natural size."

44. Fan-tailed Cuckoo, *Cacomantis pyrrhophanus,* male.
"B. Goes with A. Natural size."

45. Fan-tailed Cuckoo, *C. pyrrhophanus,* ? female.
"A. Goes with B. Natural size."

46. Golden Bronze Cuckoo, *Lamprococcocyx plagosus,* top figure.
Golden Bronze Cuckoo, *L. plagosus,* middle figure.
Rufous Whistler, *Pachycephala rufiventris,* immature male.
"These Birds drawn Natural size."
The figure of the immature male Rufous Whistler on the above sheet agrees with both "Watling" drawing No. 141 and "Lambert" drawing No. 34 (Vol. 2), either one or the other of which is the basis of *Turdus prasinus* of Latham (1801), which name has page priority over *rufiventris.* However, no change is necessary because the combination is pre-occupied by *Turdus prasinus* of Sparrman (1789).

47. Pheasant Coucal, *Centropus phasianinus.*
"This Bird is about the size of the English Pheasant. Drawn one-third of the Natural size."
The bird figured is in breeding plumage. A single feather is shown in detail, illustrating the conspicuous glossy-black extended shafts of the neck and breast feathers.

48. Glossy Black Cockatoo, *Calyptorhynchus lathami,* female.
"Reduced by scale to one-third the Natural size — Black Cockatoo."

49. Turquoise Parrot, *Neophema pulchella,* male.
"War, ran. Natural size."

50. Ground Parrot, *Pezoporus wallicus.*
"This is a Ground Parrot and never goes to a Tree or very seldom. Natural size."

51. Little Lorikeet, *Glossopsitta pusilla.*
"Natural size."

52. Musk Lorikeet, *G. concinna.*
"Natural size."

53. Eastern Rosella, *Platycercus eximius.*
"Corella, Natural size (Natural Size)."

54. Scarlet Honeyeater, *Myzomela sanguineolenta,* male.
"September — Natural size. These birds are supposed to be birds of passage and appear in flocks, the red does not show the beauty of the bird."

55. Noisy Friarbird, *Philemon corniculatus.*
"Wer, gan or the Friar. Natural size."

56. Blue-faced Honeyeater, *Entomyzon cyanotis.*
"Natural size — the outer and middle toe are connected to the first joint. No feathers grow upon the part of the head which is blue (and of the finest ultramarine)."
The last five words, which are in brackets, replace the words that have been incompletely erased; also the partly erased words "of this bird" follow the word ultramarine.

57. Noisy Friarbird, *Philemon corniculatus,* immature.
"January — Natural size — supposed to be a young Bird."

58. Brush Wattle-bird, *Anthochaera chrysoptera.*
"October — Natural size — the feathers of the neck, head, breast and Back are all pointed."

59. Brush Wattle-bird, *A. chrysoptera.*
"Natural size — the feathers of the head, neck and breast are pointed."

60. Red Wattle-bird, *A. carunculata.*
"July — Reduced by scale to half the Natural size."

61. Yellow-winged Honeyeater, *Meliornis novae-hollandiae.*
January — Natural size."

62. Noisy Miner, *Myzantha melanocephala.*
"June — Natural size."

63. Tawny-crowned Honeyeater, *Gliciphila melanops.*
"May — Natural size."

64. Brown Tree-creeper, *Climacteris picumnus.*
"Natural size Iris doubtful. Iris supposed to be a straw colour."

65. Yellow-winged Honeyeater, *Meliornis novae-hollandiae.*
"May — Natural size."

66. Grey-backed Silvereye, *Zosterops lateralis.*
"August — Natural size."

67. White-cheeked Honeyeater, *Meliornis niger.*
"June — Natural size."

68. Lewin Honeyeater, *Meliphaga lewini.*
"August — Natural size."

69. Yellow-tufted Honeyeater, *M. melanops.*
"Natural size. Iris doubtful."

70. Fuscous Honeyeater, *M. fusca.*
"August — Natural size."

71. White-naped Honeyeater, *Melithreptus lunatus.*
Yellow-Robin *Eopsaltria australis.*
Eastern Spinebill, *Acanthorhynchus tenuirostris.*
"Natural size."

72. Bell Miner, *Manorina melanophrys.*
Rufous Fantail, *Rhipidura rufifrons.*
"Natural size. Iris of both doubtful."

73. Rainbow-bird, *Merops ornatus.*
"November — Natural size."

74. Azure Kingfisher, *Alcyone azurea.*
"Ter, re, a, mar or King Fisher. Natural size."

75. Laughing Jackass, *Dacelo gigas.*
"Natural size. The outer and middle toe are connected to the second joint, the middle and inner to the first."

76. Welcome Swallow, *Hirundo neoxèna,* immature.
"January — Natural size."

77. Welcome Swallow, *H. neoxena.*
"March — Natural size — The Swallow or Martin of New South Wales."

78. Tawny Frogmouth, *Podargus strigoides.*
"Half the Natural size."

79. Owlet Nightjar, *Aegotheles cristatus,* adult.
"A young Mosquito Hawk — Natural size."

80. Diamond Dove, *Geopelia cuneata.*
"May — Natural size."

81. Wonga Pigeon, *Leucosarcia melanoleuca.*
"Drawn by scale ½ the natural size. Two of these Pidgeons were now seen for the first time December 1791. Wunga — Wungee Pigeon."

Six indistinct words follow the above remarks and this partly indecipherable notation reads: "White (?) simil (?) to (?) Game?" "Watling" drawing No. 225 appears to be a copy of the above painting though by a different artist (not Watling). Bowdler Sharpe states (1906, p. 145) that it bears the date "Dec., 1792", but, according to N. B. Kinnear, "The date is a little difficult to be quite certain about. I should have read it myself as Dec., 1791, but on looking closer with a glass the last cipher is so made that there is a distinct tail on it which is absent in the first cipher. It looks as if the "1" has been made carelessly and it could be read either way" (*in litt.* 27-8-1930). The final cipher in the date on the Sydney drawing is also not very distinct though it is apparently intended for 1.

82. Common Bronzewing Pigeon, *Phaps chalcoptera.*
"Natural size — Bronze Wing."

83. Brush Bronzewing Pigeon, *P. elegans.*
"Natural size — Bronze Winged Pigeon."

84. Norfolk Island Pigeon, *Hemiphaga spadicea.* Extinct.
"Pidgeon of Norfolk Island, drawn by scale ½ the natural size — Iris doubtful."

85. Southern Stone-Curlew, *Burhinus magnirostris.*
"Half the Natural size."

86. Southern Stone-Curlew, *B. magnirostris,* immature.
"A Night Bird. This Bird measured from the tip of the Bill to the Extr'y of the mid'e toe 30 inches."

87. Pied Oyster-catcher, *Haematopus ostralegus.*
"September — The male and female are always seen together on the rocks and the bare points but have entirely left the Harbour from being frequently disturbed, the iris is very bright. Natural size of the toe."

88. Red-capped Dotterel, *Charadrius alexandrinus,* female plumage.
"This bird runs on the ground like the sand Lark and is very common on the sands in the different parts of the harbour. Natural size."

89. Nankeen Night-Heron, *Nycticorax caledonicus.*

90. Little Bittern, *Ixobrychus minutus.*
"The size of the bird the drawing was taken from, who could extend its neck four inches in leng(th)."

91. White-necked Heron, *Notophoyx pacifica.*
"December — Iris doubtful."

92. Japanese Snipe, *Gallinago hardwicki.*
"December. Natural size — Iris doubtful."

93. Marsh Crake, *Porzana pusilla.*
"August — Natural size."

94. Eastern Swamp-hen, *Porphyrio melanotus.*
"Reduced to half the bird the drawing was taken from. August."

95. Little Grebe, *Podiceps ruficollis.*
"September. Natural size of the bird, the feathers are of a very fine texture, particularly those of the breast which have a shining silky appearance, seldom flies more than 50 or 60 yards — the wing has three joints, like most tropical birds."

96. Norfolk Island Dove-Petrel, *Pterodroma hindwoodi.*
"Bird of Norfolk Island (natural size)."

A reproduction of this drawing, together with a description of the bird, was published by Gregory Mathews (1936). The species has also been discussed and illustrated by Hindwood and Serventy (1943) and by Whitley (1938) who bestowed the specific name *hindwoodi* on this previously un-named petrel.

Apart from the above drawing no such bird, as depicted, had been recorded from Norfolk Island until recently. It was assumed that the species was exterminated soon after settlement in 1788, just as the Brown-headed Petrel, or Bird-of-Providence, *Pterodroma melanopus,* was by the inhabitants of the Island. Whitley has given (1934) details of the slaughter of that species in 1790: in a period of some four months, during a time of near famine, more than 170,000 birds were taken for food.

However, in January 1965, after a lapse of more than 170 years, the supposedly extinct Norfolk Island Dove-Petrel has been re-discovered. A specimen, collected by J. Hyett, from among numbers seen on the Island, agrees in essential details with the original drawing. It is anticipated that a full account of the "re-discovery" of this species will be published at some future date, probably in the pages of the *Emu,* journal of the Royal Australasian Ornithologists' Union.

97. Wedge-tailed Shearwater, *Puffinus pacificus.*
"Bird of Norfolk Island, commonly called the mutton-bird — drawn the natural size."

98. Pied Goose, *Anseranas semipalmata.*
"This bird is about the size of a Goose — an outline of the foot drawn the natural size."

99. Red-tailed Tropic-bird, *Phaethon rubricaudus,* immature.
"A young Tropic Bird, half the natural size."

100. Red-tailed Tropic-bird, *P. rubricaudus,* adult.
"Tropic-bird. Natural size."

101. Red-tailed Tropic-bird, *P. rubricaudus,* adult.
"The Tropic Bird or Alma do Comtra-Mastre. From the tip of the bill to the rump 18 inches, from the rump to the end of the tail 18 inches — from the extremity of the wings 4 feet 2 inches — the whole bird is covered with a bloom w'ch is not shown in the Drawing—by the rays of the Sun."

The last five words in the above remarks were the end of a sentence the first part of which has been erased and replaced with the statement beginning "bird is covered . . ."

PUBLISHED "SYDNEY" PAINTINGS

In addition to the eight illustrations in this paper the following "Sydney" drawings have appeared in print.

No. 35. Emu-Wren in the *Emu*, vol. 31, 1931, pl. 24.

46. Golden-bronze Cuckoo (centre figure of three on the sheet), in the *Australian Museum Magazine*, vol. 4, No. 3, July-September, 1930, p. 84.

47. Pheasant Coucal, in the *Australian Museum Magazine*, vol. 4, No. 1, July-March, 1930, p. 20.

50. Ground Parrot, in the *Emu*, vol. 32, 1933, pl. 33: also in *Australian Parrots* (N. W. Cayley), 1938, opp. p. 304.

96. Norfolk Island Dove-Petrel, in a *Supplement to the Birds of Norfolk and Lord Howe Islands* (Gregory M. Mathews), 1936, opp. p. 94 (lower figure); also in the *Australian Museum Magazine*, vol. 6, No. 9, January-March, 1938, p. 297, and in the *Emu*, vol. 42, 1943, pl. 16.

ACKNOWLEDGEMENTS

I first became interested in the "Sydney" paintings in 1929, in which year the basic work of identification was undertaken, where necessary by comparison with Museum specimens. My thanks are extended to both past and present members of the staffs of both the Public Library of New South Wales and the Mitchell Library, Sydney, for assistance; also to A. H. Chisholm, Tom Iredale and Gilbert P. Whitley for co-operation and advice.

The Trustees of the Mitchell Library are thanked for permission to reproduce drawings from the "Sydney" collection from photographs by the author.

REFERENCES

Campbell, A. J., 1912—A History of Australian Ornithological Research. *Emu* 11:154.

Hindwood, K. A., 1931—Historical Associations and Early Records of the Emu-Wren. *Emu* 31:100.

Hindwood, K. A., 1933—The Ground Parrot. *Emu* 32:246.

Hindwood, K. A. and Serventy, D. L., 1943—Further Notes on *Pterodroma leucoptera*. *Emu* 42: pl. 16.

Hindwood, K. A., 1964—George Raper, an Artist of the First Fleet. *Journal and Proceedings, Royal Australian Historical Society*. 50:32-57.

Hunter, John, 1793—*An Historical Journal of the Transactions at Port Jackson and Norfolk Island*, London.

Latham, John, 1801—*Index Ornithologicus Supplementum*. 51.

Mackaness, George, 1937—*Admiral Arthur Phillip*, Sydney. 458.

Mathews, Gregory M., 1936—*Supplement to the Birds of Norfolk and Lord Howe Islands*. pl. opp. 94.

Phillip, Arthur, 1789—*The Voyage of Governor Phillip to Botany Bay*, London.

Sharpe, R. Bowdler, 1906—*History of the Collections, British Museum (Natural History), Birds.* 140.

Shaw, George, 1794—*Zoology and Botany of New Holland, London.* pl. 9.

Sparrman, Anders, 1789—*Museum Carlsonianum.* Stockholm.

White, John, 1790—*Journal of a Voyage to New South Wales.* London.

Whitley, G. P., 1934—The Doom of the Bird of Providence. *Australian Zool.*, 8:42-49, pl. 1.

Whitley, G. P., 1938.—Naturalists of the First Fleet. *Austr. Mus. Magazine.* 6(9):297-301 illustr.

SOUTH PACIFIC COMMISSION

Banded and Marked Birds

Although it is known that some kinds of birds perform remarkable annual migrations of 10,000 miles or more over the North and South Pacific Oceans, the regular travels of most species are unknown or poorly understood. In an endeavour to learn more about the migrants of seabirds, ornithologists from the Smithsonian Institution, Washington, D.C., have captured, marked, and released in the Central Pacific over 300,000 birds of 28 different kinds, with aluminium legbands. Of these, over 60,000 have been marked with plastic leg-streamers.

Anyone coming into the possession of a banded dead bird in the Pacific Ocean area is asked to co-operate by returning the band, together with time and place of recovery, as instructed on the band. For live birds, only the band number, together with time and place of capture, need be sent. The bird should then be liberated so that its further travel may be traced. Anyone sighting a bird with a coloured leg-streamer anywhere in the Pacific Ocean area is asked to co-operate by recording the name or description of the kind of bird wearing the streamer, the streamer colour, the date seen, and the latitude and longitude or approximate location of sighting. All information on these birds should be sent as soon as possible to Division of Birds, Smithsonian Institution, Washington, D.C. 20560.

FRANCOIS LAPORTE

Count Castelnau (1810-1880).

By G. P. Whitley

(Plate x.)

More and more, modern zoologists are finding that it is necessary to study closely the work of naturalists of the past. Biographies and bibliographies of our predecessors are laborious to compile but it is hoped that this account of a much-travelled nineteenth century French zoologist may be useful to those seeking information as to his activities and his type-localities and may be a minor contribution to the history of Australian zoology.

The naturalist and traveller, François Laporte, Comte de Castelnau, was born on Christmas Day, 1810, in London, England, and died at his residence, Apsley Place, East Melbourne, Victoria, on February 4th, 1880. He is sometimes called Laporte or Delaporte in literature, but usually signed his papers F. L. de Castelnau or, on occasion, "M. de los Llanos Montanos."

The histories of Captain Cook and de Levaillant were the fairy tales of Castelnau's infancy. As a young man in Paris he studied natural science under Cuvier, Geoffroy Saint-Hilaire, Brougniart, Elie de Beaumont, de Jussieu, de Blainville, Desfontaines, A. Duméril, Latreille, and other famous zoologists at the Jardin des Plantes.

Between 1824 and 1840 Castelnau produced many entomological papers (mostly on Coleoptera and Hemiptera) which were published in French Journals. He commenced his work on Jewel Beetles, Buprestidae, with Gory in 1827.

For five years he travelled through the United States, Texas, and Canada* and on his return issued *Vues et souvenirs de L'Amerique du Nord* and other accounts. After returning to France he received the Royal Commission to explore South America, for which voyage he left Paris on 22nd April, 1843. The trip from Le Havre to New York took 36 days. Castelnau saw some of the d'Urville collection in Washington and later made the acquaintance of the eccentric naturalist Rafinesque.

In 1839, Castelnau published an account of the Wakulla River, Florida, in the *Bulletin of the Soc. Geogr. Paris* 11, pp. 242-247, much of his work having been done in the territories "de la Floride, du Ouisconsin et au Canada". He must have been interested in fishes from an early age as Cuvier and Valenciennes described an anchovy from his New York collection in 1848 (Hist. Nat. Poiss. 21, ed. 2, p. 31).

In 1847 Cuvier and Valenciennes described in the same work fishes sent to Paris from Brazil by Castelnau in his "riches et belles collections." Castelnau spent three years (1843-47) in going overland on mules and horses from Rio de Janeiro to Lima but lost many of his specimens. He considered the Llamas in Peru with the idea of acclimatizing them in France. At a later date, perhaps, he may have influenced the persons such as Ledger who wished to introduce Llamas and Alpacas into Australia.

Baron von Muller used to wear an old muffler made of angora wool with the ends hanging down. This angora scarf was historical, and was one of several which had been made from wool that Count de Castelnau, French Consul-General at Melbourne in the sixties, gave him (Maiden, Proc. Roy. Soc. N.S.W. XLVI, 1912, p. 10).

---

* See *Voyages autour du monde . . . mis en ordre par William Smith*, wherein Castelnau's travels, particularly those in Florida, Wisconsin and Canada were ranked with those of the most famous voyageurs. Smith's volume, which I have consulted in the Mitchell Library, Sydney, was undated.

After the revolution of 1848, Castelnau was appointed French Consul at Bahia, Brazil. He was director of the scientific expedition sent by King Louis Phillipe of France to South America and secured many fishes from the River Amazon.

A map of his travels has been provided by Eigenmann (1917, *Mem. Mus. Comp. Zool. Harvard* 43, plate 1.)

Castelnau's South American fishes were deposited in the Jardin des Plantes, where, assisted by Guichenot and other zoologists, he compared them with Cuvier and Valenciennes' types. *Pellona castelnaueana* Cuv. and Val. was a new fish from this expedition, the full report on which was published by Bertrand of Paris in 1859 with coloured plates.

For three years, Castelnau was at the Cape of Good Hope, where he wrote his Memoire sur les Poissons de l'Afrique australe, published in Paris early in 1861, an abridgement of a book he had spent two years (1856-58) in preparing with coloured figures made from as many living species as he could observe. He virtually dedicated this *Memoire* to Mons. A. Duméril, one of his teachers of zoology in Paris.

Castelnau travelled over Caffraria in South Africa. Then he was appointed French Consul at Siam where he was the first European to study the fishes of Thailand* and also visited India, Malacca, Sumatra, Java, Ceylon and Singapore (1859). His Siamese fish collection was reported upon by the Dutch ichthyologist, Pieter Bleeker (1859, *Nat Tijdschr. Ned. Ind.* 20, pp. 101-102), who also dealt with his fishes from Singapore (*ibid.*, pp. 216-217 and 236-239).

When in about 1860 Castelnau returned to Europe and began to put his voluminous notes and drawings in order he found that, while he had been temporarily indisposed or disabled, his valet had been for more than a month in the habit of using the sheets of his manuscript for lighting fires and other purposes of the most menial nature. Castelnau disposed of the remainder of his notes to Professor Lacordaire, of Liège University.

Castelnau's industry must have been amazing. He wrote on geography, palaeontology and anthropology, on mammals, birds and reptiles as well as on fishes and insects, his favourite subjects in zoology. His method of mounting his specimens has been described by E. R. Waite (1921, *Rec. S. Austr. Mus.* 2, p. 2, fig.) and Anderson (1930, *Museums Journal* 29, p. 253 and 30, p. 32); the Australian Museum still has a few samples of his taxidermy.

Castelnau came to rest in Australia after his exhaustive travels in so many countries, arriving in Melbourne from Europe in 1862. Here as Consul General of France, Castelnau interested himself in ichthyology, visiting the Fish Markets frequently and describing many species. He was an active member of the Zoological and Acclimatization Society of Victoria and joined the Entomological Society of New South Wales in October, 1863. To his friend M. Paul Gervais, Paris Museum, he sent several notes of interest which were occasionally published, notably in his *Journal de Zoologie*. A Mons. Adet of Melbourne collected fishes at Noumea during his few months sojourn there. These were later described by Castelnau in *Proceedings Zool. Acclim. Soc. Vict.* II.

In June 1876, Castelnau was in Brisbane.

Castelnau also employed among others, a collector named Girardin to obtain beetles from Port Denison, Queensland, and he wrote a series of articles on Australian coleoptera in *Trans. Proc. Roy. Soc. Vict.* VIII, 1868. Castelnau came to Sydney from Melbourne in about 1876. The Report of the Australian Museum for 1877 acknowledges a large collection from "Le Comte de Castelnau." A new fish (*Kurtus gulliveri*) and many birds were included. Castelnau seems to have persuaded Gervais to exchange specimens

* H. M. Smith, 1945, U.S. Nat. Mus. Bull. 188, p. 5.

with the Australian Museum in 1879. He visited the fish markets in Sydney almost daily and his Essay on the Ichthyology of Port Jackson was published by the Linnean Society of New South Wales in 1878.

The Australian Museum had specimens from Castelnau, such as Brazilian birds (nos. A.321 onwards), a Bat, received in September 1876, and some skins of fishes, some still extant, registered nos. A.7126 et seq. in 1878 or 1879.

In the National Museum, Melbourne, through the courtesy of the then Director (Mr. C. Brazenor) I saw the Castelnau collection of beetles. Some of Castelnau's original cabinets (probably made in Africa) were in that Museum but all the specimens had been transferred into more modern drawers. There are numerous Coleoptera from various parts of the world each pinned on a square or shield of cork. The generic names were also on cork whilst the specific names and authors or localities were on labels pasted on to the cork support of each beetle. Where a species was not represented by a specimen, a coloured figure was included, also on a cork shield, so that a continuous series of genera and species was presented. Perhaps there are no types here, since the original key collection was probably left by Castelnau in France or Belgium. There are, however, types of Castelnau's Carabidae in the Howitt Collection in the National Museum, Melbourne, on loan from the University of Melbourne.

It may not be out of place to refer to notes on some of Castelnau's type specimen of fishes, since the Count's original descriptions of fishes are often, unfortunately, inaccurate or not sufficiently complete for modern purposes. Most of his types appear to be in the Paris Museum*, but there are a few in Australian museums. The type of the Swordfish (*Histiophorus granulifer* Castelnau) is noted by Jordan and Evermann (Occas. Pap. Calif. Acad. Sci. XII, 1926, p. 39, footnote).

The types of *Aploactisoma schomburgkii* are noted by McCulloch (1915, Proc. Linn. Soc. New South Wales, 40, p. 273). When preparing his revision of the Galaxiidae, Regan (Proc. Zool. Soc. London 1905. pp. 363-384) had from Paris all of Castelnau's types that could be found. That of *Galaxias amaenus* was unfortunately missing.

About October 1877, the laboratory of Ichthyology of the Paris Museum received many types of Castelnau's species, labelled by their author (Vaillant, 1903, Bull. Mus. d'Hist. Nat. 9 (3), 1903, p. 118, foot-note).

The disappearance of many of Castelnau's types is unfortunate. In this category, we must place *Torresia australis* (vide Ogilby, Proc. Zool. Soc. Lond. 1889, p. 158) and some African freshwater ones (Trewaves, 1964).

Castelnau's types of Pomacentridae have been figured by Rivas (1960, Quart. J. Florida Acad. Sci. 23, pp. 130 and 138, figs. 1, 4, 5 & 8). Bleeker's *Apogon* spp. from Castelnau's material are discussed by Weber and Beaufort (1929, Fish. Indo-Austr. Archip. 5, p. 349).

Many species and some genera of insects as well as fishes have been named in honour of Castelnau and the stinging plant, *Laportea,* of tropical Australia also commemorates him.

Some of Castelnau's manuscript names for fishes have undoubtedly been used by later writers, for example, *Stenarchus bonaparti* in Kaup (1856, Archiv. Naturges. 22(1), p. 79).

BIBLIOGRAPHY OF CASTELNAU'S WRITINGS

1824. (By Mons. de Laporte = ? François Laporte)
Extrait d'une lettre relative à quelques eclaircissements sur le Sylphium. *Soc. Geogr. Bull.* 2, pp. 234-235.

* The Plectognathi have been listed by Le Danois, 1960, Bull Mus. Nat. Hist. Nat. Paris (2) 32, 513.

1824. (By Castelnau, jun. = ? François Laporte)
Extrait d'une lettre concernant la découverté d'os fossiles d'un Mastodonte.
Bull. Sci. Nat. (Ferussac) 3, p. 75.

1826. (By F. L. de Laporte, Comte de Castelnau)
Description d'une nouvelle espèce de reptile du genre Marbré (Polychrus).
Ann. Sci. Nat. 9, pp. 110-111.

1828. (By Laporte and Auguste Brullé).
Notice sur un nouveau genre de la famille des charançons (Gasterocerius) de la division des Cryptorhynchides.
Mem. Soc. Hist. Nat. Paris 4, pp. 197-203;
Bull. Sci. Nat. (Ferussac) 17, 1829, pp. 314-316; and *Annal. des Sc. d'observation par Raspail* 1, 1829, p. 152.

1830. Observations pour servir à l'histoire de quelques Insectes (Coléopt, Lepidopt.).
Act. Soc. Linn. Bordeaux 4, p. 16, pl. 1.

1831. Description du *Enicotarsus viridipennis.*
Mag. de Zool. (Guérin) (1) 1 (2), pp. 35-35 bis, Insecta, plate 35.

1831. (By Laporte and Brullé).
Monographie du genre *Diaperis.*
Ann. Sci. Hist. Nat. 23, pp. 325-410; *Isis* 3, 1835, p. 288.

1831. Description de l' *Eurydera armata.*
Mag. de Zool. (Guérin), 1 (2), pp. 36 to 36, bis, pl. 36.

1832. Notice sur le Macrotoma, nouveau genre de Diptère de la famille des Muscides.
Ann. Sci. Nat. 25, pp. 457-460, pl. X, A; *Isis* 4, 1835, p. 471.

1832. Description du *Calicnemis Latreilli, Lap.* (Pachypus truncatifrons, *Dej. Catal.*).
Mag. de Zool. (Guérin) 2, 7, Cl. ix, pl. 7.

1832. Description de la *Stenocheila Lacordaerei.*
Mag. de Zool. (Guérin) 2, Cl. ix, pl. 12.

1832. Description de *l'Oplopus atriplicus.*
Mag. de Zool. (Guérin) 2(20), Cl. ix, pl. 20.

1832. *Pachyderma nigricans.*
Mag. de Zool. (Guérin) 2. Cl. ix, pl. 37.

1832. Description du *Trachalus rotundatus.*
Mag. de Zool. (Guérin) 2, Cl. ix, pl. 44.

1832. Essai d'une classification systematique de l'ordre des Hémiptères.
Mag. de Zool. (Guérin) 2, Cl. ix, pp. 1-88, pls. 51-55. (Pl. 55 missing in Publ. Library, Melbourne, copy). Supplement in pages 76-88. Review in *Isis* 2, 1842, pp. 52-56.
Reprinted, 8vo, pp. 88, 5 pls., 1832.

1832. Notice sur un nouveau genre de l'ordre des Homoptères (Heteronotus).
Ann. Soc. Entom. (Paris) 1, pp. 95-98, coloured fig.

1832. Mémoire sur quelques nouveaux genres de l'ordre des Homoptères (Poiocira, Germaria, Schizia, Atypa, Pterygia, Acanthieus).
Ann. Soc. Entom. 1, pp. 221-231.

1832. Mémoire sur cinquante espèces nouvelles ou peu connues d' insectes.
Ann. Soc. Entom. 1, pp. 386-415, 448.

1832. (Corrections to) Audinet-Serville, Nouvelle Classification des longicornes.
Ann. Soc. Ent. 1, pp. 443-444.

1833. Mémoire sur les divisions du genre *Colaspis.*
Revue Entom. (Silbermann) 1, pp. 18-25; *Ann. Sci. Nat.* (2) iii, 1855, p. 187.

1833. (Pedaria nigra) etc.
Ann. Soc. Ent. 1 (4), p. 403.

1833. Ctenidia mordelloides.
L'Institut 1, p. 173.

1833. Coleoptères et Hemiptères nouveaux.
Rev. Entom. (Silbermann) 1, pp. 32-36; *L'Institut* 1 (20), p. 173 (*fide* Hagen).

1833. Essai d'une revision du genre lampyre.
Ann. Soc. Ent. France 2(1), pp. 122-153; *Isis* 7, 1846, p. 490.

1833. Note monographique sur le genre *Oxycheila*.
Rev. Entom. (Silbermann) 1, pp. 126-130.

1833. Note monographique sur le genre *Zuphium*.
Rev. Entom. (Silbermann) 1, pp. 251-257.

1833. Note sur un nouveau genre et un nouvel insecte homoptère.
Ann. Soc. Entom. 2, pp. 251-253.

1833. Monographie du groupe des Rhipicérites (Coléoptères Pentamères).
Ann. Soc. Ent. 3, pp. 225-270, pl. ii; *Isis* 7, 1846, p. 507.

1834. Observations sur le genre *Prostemma* et sur le memoire de Ms L. Dufour.
Ann. Soc. Ent. 3, Bull. pp. vii-viii.

1834. Observations sur la tribu des Cicindélètes.
Rev. Entom. (Silbermann) 2, pp. 27-39.

1834. Extrait du premier numéro de l'Entom. Magas.
Rev. Entom. (Silbermann) 2, pp. 40-44.

1834. Extrait de son essai et classification des Hemiptères.
Rev. Entom. (Silbermann) 2, pp. 44-47.

1834-6. Etudes entomologiques ou description d'Insectes nouveaux et observations sur leur synonymie Pt. i. Carnassiers. 8vo, 159 pp., 4 coloured plates (Paris: Méquignon — Marvis, 1834.) Continued in *Rev. Entom.* (Silbermann) 3, 1835, pp. 157-181 and 4, 1836, pp. 5-60.

1834. Description d'une nouvelle espèce de Mégacephales.
Rev. Entom. (Silbermann) 2, pp. 83-84.

1834. (By Laporte and Auguste Chevrolat).
Description de deux nouvelles Mégacephales.
Rev. Entom. (Silbermann) 2, pp. 83-85.

1834. (Ptiocerus brunneus) etc.
Ann. Soc. Ent. France 3 (2), post June 1834, p. 265.

1835. Sur. une classification des Hémiptères (Heteropt.).
L'Institut 3 (90), p. 30.

1835-41 (By Delaporte and H. Gory).
Histoire naturelle et iconographie des Coléoptères.
52 livr. of 5 plates, gr. in octavo, Paris.
Vols. i, ii. Histoire naturelle des animaux articulés:-
Histoire naturelle des Insectes Coléoptères, avec une introduction par M. Brullé. 2 vols., with figs.
1835-40.
Vol. iii. Histoire naturelle des Insectes Orthoptères, Neuroptères, Hémiptères, etc., par Emile Blanchard, avec une introduction par M. Brullé. 3 vols., 1840-41. Final parts by Gory as Castelnau had gone to South America. For dates of publication, see Sherborn's Index Animalium. Hagen quotes an edition de luxe, vol. iv: "Monographie des Psilocera, Eurydera, Nycteis, Eunostus, Buprestides" — supplement to Buprestides is by Gory (see *Rev. Zool.*, 1840, p. 340 and 1841, p. 392). Published in separate monographs.

1835. (By Delaporte)
Monographie du genre *Clytus*. 124 pp.
8vo. (Paris: J. B. Baillière). Separate from Hist. Nat. Coleopt. Also in *Comptes Rendus*, Paris, 2, 1836, pp. 10-12.

1836. Rectification des Homoptès de la 29 livr. des "Illustrations de Zoologie" de M. Lesson.
Ann. Soc. Ent. 5, Bull., pp. vii-x.

1836. Notice sur le système nerveux des Insectes (Silpha carinata vivant avec le corps presque dévoré).
Ann. Soc. Ent. 5, Bull., pp. xxxii-xxxiv.

1836. Etudes entomologiques ou descriptions d'insectes nouveaux et observations sur la synonymie.
Rev. Entom. (Silbermann) 4, pp. 5-60.

1837. Essai pour servir à l'Histoire des Sociétiés Entomologiques.
Ann. Soc. Ent. 6, pp. 5-13; *Isis* 6, 1848, p. 431.

1839. Note sur la source de la rivière de Wakulla dans la Floride.
Bull. Soc. Geogr. Paris. 11, pp. 242-247.

1839. Traité élémentaire d'entomologie.
(Paris: Terzulolo), 12 mo. pp. ...., 1 plate.

1840, onwards.
Histoire naturelle des animaux articulés, Annel., Crust., Arach., Myr. et Insect.
Vols. i-ii, Coleoptera by Laporte (Castelnau).
For details see Schenkling, 1939, J. Soc. Bibliogr. Nat. Hist. 1(7), pp. 213 et seq.
Volume IV reissued 1850, annelides by Laporte — fide Sherborn, Index Animalium 2 (2), 1923, p. cxxxv.

1842. (Observations sur les moeurs des Reptiles)
Rev. Zool. 1842, p. 93.

1842-3. Communiqué à l'Academie des Sciences de Paris la découverte des pieds des Trilobites qu'il aurait vus dans l'interieur d'un exemplaire enroulé de l'Amerique du Nord.
L'Institut 1842, p. 74; *Comptes Rendus* 14, p. 344-345; *Neues Jahrbuch für Mineral.*, 1843, p. 504.
See Vogdes, Occas. Pap. Calif. Acad. Sci. 4, 1893, p. 34, Bibliogr. Palaeoz. Crust.

1842. Sur les moeurs de certains Ophidiens.
Comptes Rendus 14, pp. 492-495;
L'Institut 10, p. 114.

1842. Essai sur les Séminoles de la Floride.
Bull. Soc. Geogr. Paris 17, pp. 392-403.

1842. Note sur deux itineraires de Charleston à Tallahasée.
Bull. Soc. Geogr. Paris 18, pp. 241-259.

1842. Observations entomologiques sur les insectes de l'Amerique du Nord.
Ann. Soc. Ent. 11, Bull., pp. xii-xiii.

(date?) Voyage dans l'Amérique septentrionale et particulièrement dans les territoires de la Floride, du Ouisconsin et au Canada, 1837-41. *In* Duponchel, A. Nouv. bibl. des Voyages, v. 12. (Public Library Melbourne).

1842. Vues et souvenirs de l'Amérique du Nord.
(Paris: A. Bertrand), pp. i-viii, 1-165, 35 plates.

1842. Sur les révolutions geologiques des parties centrales de l'Amerique du Nord.
Comptes Rendus 14, pp. 610-613; Froriep, *Notizen* 23, cols. 99-101.

1843. Note sur une seconde espece du genre *Stenidia* et sur un *Ctenodactyla* nouveau.
Mag. Zool. (Guérin) 13, p. 1943, pl. 119.

1843. Essai sur le système Silurien de l'Amérique septentrionale.
Paris and Strasburg, 4o, pp. 56, 27 plates.
Preceded by Rapport sur un Memoire de F. de Castelnau . . . Reprinted from *Comptes Rendus,* 1843.
See Ehlers & Wright, Contrib. Mus. Palaeont. Univ. Michigan 13, 1957, pp. 175-180.

1846. Observations relatives a quelques animaux domestiques de l'Amérique méridionale (le Lama, la Vigogne; fécondité d'une mule; le Couguar).
Rev. Zool. Soc. Cuvier 1846, p. 231; *Comptes Rendus* 22, pp. 1002-1004; Froriep, *Notizen* 39, cols. 213-215, as Ueber einige Hausthiere Sudamerica's.

1847. Rapport sur l'esclavage à Surinam . . . .
Ann. Marit. et Colon. (Paris: Bajot & Poirre) 8vo. pp. 41 (Public Library, Melbourne).

1847. Note sur le Lama, l'Alpaca, et la Vigogne, et sur l'utilité de leur importation en France et en Algerie.
Comptes Rendus 25, pp. 907-909; also in I. G. Saint-Hilaire, *Rev. Zool. Soc. Cuvier,* 1847, p. 403.

1847-8. Considérations sur la distribution des Reptiles et en particulier, des Ophidiens, dans l'Amérique du Sud.
L'Institut 16, pp. 19 and 72; *Comptes Rendus* 26, 1848, pp. 101-102.

1848. Considérations generales sur l'ornithologie de l'Amérique tropicale.
Rev. Zool. Soc. Cuvier. pp. 89-90; *Comptes Rendus* 26, pp. 306-307; *Arch. Sci. Phys. Nat.* 8, p. 72.

1850-9. Expedition dans les parties centrales de l'Amérique du Sud . . . pendant . . . 1843 a 1847. Fourteen volumes or Seven parts in 21 volumes, some octavo, others folio. The first four volumes (Histoire du Voyage, 2 vols, Geology, etc.) and the Fishes are by Castelnau. For details, see *Cat. Books Brit. Mus.* (*Nat. Hist.*) 1, 1903, p. 325. For dates of publication see Sherborn & Woodward, *Ann. Mag. Nat. Hist.* (7) 8, 1901, p. 164.
The Botany by Weddell reprinted at Leipzig, 1922.

1851. Sur les Niam-Niams ou hommes a queue.
Bull. Soc. Geogr. Paris. 2, pp. 25-27.

1851. Renseignements sur l'Afrique centrale et sur une nation d'hommes à queue qui s'y trouverait, d'après le rapport des nègres du Soudan, esclaves à Bahia. (Paris: Bertrand) 8vo. 63 pp., 4 plates. (Publ. Lib., Melbourne).

1859. Abondance des Tigres dans l'ile de Singapore.
Rev. Mag. Zool. (2) 11, pp. 401-402; *Comptes Rendus* 49, pp. 413-414.

1860. Note sur les poissons de l'Afrique australe.
Comptes Rendus 50, pp. 788-789.

1861. Mémoire sur les Poissons de l'Afrique australe.
(Paris: J. B. Bailliere), pp. vii + 78.

1861. Pluie de Poissons; tremblement de terre à Singapore.
Comptes Rendus 52, pp. 880-882; *Zoologist* 19, p. 7, 649; *Science pour tous* 6, p. 191.

1862. Note sur un Scaritide gigantesque du Laos.
Rev. Mag. Zool. (2) 14, pp. 305-306. See also H. Mouhot, *Trav. Cent. Indo-China* ii, Appendix.

1863. Note sur le genre *Manticora.*
Rev. Mag. Zool. (2) 15, pp. 64-73.

1867. Note sur un nouveau genre de Dynastide (*Alcidosoma*) *Rev. Mag. Zool.* (2) 19, pp. 113-115.

1867-8. Notes on Australian Coleoptera.
Trans. Proc. Roy. Soc. Vict. 8, pp. 30-38 (part i); part ii in *ibid* pp. 95-225, with which it was issued in one 8vo. vol., Melbourne, 1868.

1869. Description du nouveau genre *Nepharis,* Coléoptère de la famille des Colydiens, tribu des Dynchitites.
Rev. Mag. Zool. (2) 21, pp. 356-357, pl. xviii, figs. 4-5.

1872. Contribution to the Ichthyology of Australia.
No. i. — The Melbourne Fish Market.
Proc. Zool. Acclim. Soc. Vict. 1, pp. 29-242, plate.

1872. Contribution to the Ichthyology of Australia.
No. ii. — Note on some south Australian Fishes.
Proc. Zool. Acclim. Soc. Vict. i, pp. 243-248 (including errata and observations). And published separately. Reviewed anonymously in the *Australian Mechanic and Journal of Science and Art* 1 (12), 1872, pp. 148-149 and in the *Journal Zool.* 2, 1873, pp. 47-48 and 3, 1874, pp. 85-88.

1873. Notes on the Edible Fishes of Victoria.
Intercolonial Exhibition Essays, Victorian Exhibition 1872-73, no. 5, pp. 1-17; *Journal de Zoologie* (Gervais) 3, 1874, pp. 144-157 (Résumé in French).

1873. Description d'un nouveau genre de Goliathide. Westwoodia.
Rev. Mag. Zool. (3), 1, pp. 397-399, reprinted, pp. 1-2, pl. 17, fig. 2. (Publ. Library, Melbourne).

1873. Contribution to the Ichthyology of Australia.
No. iii. — Supplement to the Fishes of Victoria.
iv. — Fishes of South Australia.
v. — Notes on Fishes from North Australia.
vi. — Notes on Fishes from Knob Island.
vii. — Fishes of New Caledonia.
viii. — Fishes of Western Australia.
ix. — New Sorts for the Victorian Fauna, and List of Australian Fishes.
Proc. Zool. Acclim. Soc. Vict. 2, pp. 37-158.

1875. Fishes. *Philad. Centen. Exhib.,* 1876 (Melbourne, 1875) *Official Record,* pp. 105-108.

1875. Researches on the Fishes of Australia.
Official Record Philadelphia Exhibition.
Intercolonial Exhibition Essays. no. 2, pp. 1-52.
See Gill, *Proc. U.S. Nat. Mus.* 14, 1891, pp. 401-402.

1876. Mémoire sur les poissons appelés barramundi par les Aborigènes du nord-est de l'Australie.
Journ. Zool. (Gervais). 5, pp. 129-136.

1876. Remarques au sujet du genre *Neoceratodus.*
Journ. Zool. (Gervais) 5, pp. 342-343.
Compare also *Comptes Rendus,* May 1, 1876, p. 1034; *Ann. Mag. Nat. Hist.* (4) 17, 1876, p. 486.

1877. (By Castelnau and E. P. Ramsay).
Notes of a collection of birds from the Norman River, Gulf of Carpentaria, with descriptions of some new species.
Proc. Linn. Soc. N.S.Wales 1, pp. 379-386.

1878. Australian Fishes. New or little known species.
Proc. Linn. Soc. N.S.Wales 2, pp. 225-248, pls. ii-iii.

1878. Notes on the Fishes of the Norman River.
Proc. Linn. Soc. N.S.Wales 3, pp. 41-51.

1878. On some new Australian (chiefly) Freshwater Fishes.
Proc. Linn. Soc. N.S.Wales 3, pp. 140-144.

1878. On a new Ganoid Fish from Queensland.
Proc. Linn. Soc. N.S.Wales 3, p. 164, pl. xix, A.
See Whitley, *American Naturalist* 67, 1933, pp. 1-4, figs. A-C.

1879. Essay on the Ichthyology of Port Jackson.
Proc. Linn. Soc. N.S.Wales 3, pp. 347-402.

1880. The Freshwater Aquarium of the Trocadero Palace at Paris.
Victorian Review 1, pp. 769-786.

WORKS CONSULTED

Abeille 24, 1886-7, pp. 145-147, *fide* Roy. Soc. Cat. Sci. Papers.

American Naturalist 1880, 14, pp. 548-549.

Argus (newspaper), Melbourne, 5 February 1880 (obituary).

Augé, *Nouv. Larousse.*

Australasian Sketcher (newspaper), Melbourne, all 1880, especially 14 February, 1880.

Australian Museum, Reports of the Trustees of the.

Australian Museum (MS. library catalogue).

Berland, 1932, Soc. Entom. France, *Livr. Centen.,* p. 163.

Blackwelder, 1957, *Bull. U.S. Nat. Mus.* 185, pp 1162-1163.

Bleeker, 1859-1860, *Nat. Tijdschr. Ned Ind.* 20, pp. 101-102, 216-217 and pp. 236-239.

British Museum, Catalogue of the Library of the.

Carpenter, 1945, *Amer. Midland Nat.* 33, p. 16.

Carus & Engelmann, *Bibl.*

Dean, Bashford, 1923, *Bibliography of Fishes.*

Eigenmann, 1917, *Mem. Mus. Comp. Zool.*, Harvard, 43, plate 1.
Engelmann, 1846, *Bibl. Zool.*
Engelmann, 1894, *Bibl. Zool.* 2(4), 1861-1880, p. 3374.
Entomological Soc. N.S.Wales, *Transactions.*
Ferguson, J. A., 1941-63, *Bibliography of Australia,* i-v.
Illustration (Paris), 1847, p. 60, portrait.
Jordan, D. S., 1919, *Genera of Fishes.*
Library of Congress, *Catalog of Books represented by Printed Cards,* 26, 1958, pp. 92-93.
Linnean Soc. N.S.Wales, *Proceedings, Sydney,* 1-3, 1877-9.
McCulloch, A. R., manuscript cards.
Magasin de Zoologie (all available Volumes in Australian Museum and Linnean Society, Sydney.
Masters, G., 1871-87, *Cat. Coleopt.* and *Proc. Linn. Soc. N.S.Wales.*
Mitchell Library, Sydney, Manuscripts and books.
Museum Journal 1930, vols. 29, p. 253 and 30, p. 32.
Musgrave, A., 1932, *Bibl. Austr. Entom.*
Nachtrichtsblatt der Deutschen Malakozoologischen Gesel. Jahr. 13, 1881, p. 14.
Natural History (New York) 1930, 30, p. 668.
Naturaliste 1880, 26, pp. 207-208.
Nature 1880, 21, p. 500.
Nomenclator Animalium 1926, 1 (5), Litt., p. cxc.
Philosophical Institute of Victoria, *Transactions.*
Public Library, Melbourne, 1906, *Cat. exhib. old. rare, curious books* etc. Also manuscripts.
Revue et Magazin de Zoologie, Paris.
Rivas, 1960, *Q. J. Florida Acad. Sci.* 23, pp. 130 & 138.
Royal Society's Catalogue of Scientific Papers, London, 1867-1925, vols. 1-9.
Royal Society of New South Wales, *Proceedings.*
Royal Society of Victoria, *Transactions and Proceedings,* vol. 8, etc.
Schenkling, 1939, "Uber Castelnau, Histoire naturelle des Animaux articulés" *J. Soc. Bibliogr. Nat. Hist.* 1 (7), p. 213.
Sherborn, C. D., 1922-33, *Index Animalium,* 1801-1850.
Smith, William. (no date), *Voyages autour du Monde* (Société bibliophile à Paris). Copy in Mitchell Library, Sydney.
Trewavas, 1964, *Kon. Mus. Midden-Afrika Ann.,* Zool. Wetensch. 125, p. 11.
Vaillant, 1903, *Bull. Mus. Hist. Nat.* 9 (3), p. 118, footnote.
Victorian Review, 1, 1880.
Waite, E. R., 1921, *Rec. S. Austr. Mus.* 2, p. 2, fig.
Whitley, 1948, *Aust. Mus. Mag.* 9, p. 244.
Whittell, 1954, *Literature of Australian Birds.*
Zimmer, 1926, *Field Museum Zool. Series* 16, p. 125.
Zoological Society of London, *Proceedings,* 1855-1881.
Zoologische Anzeiger, 1880, 3, p. 168.

Many other works were consulted with negative results where Castelnau was concerned.

ACKNOWLEDGMENTS

The preparation of this paper has been spread over more than 30 years; it has been written (in moments spared from other work) in libraries and Museums in Australia, England and Europe. I am indebted to the librarians of the British Museum (Natural History), Bibliothèque National (Paris), Public Library and National Museum (Melbourne), the Mitchell Library and the Australian Museum (Sydney) for valued assistance. Later workers may find still more information in American, French or Belgian libraries to which my visits were all too brief. My late friend, Anthony Musgrave, gave his usual generous help.

I am particularly grateful to M. Roger Loubère who, when he was Vice-Consul for France in Melbourne in 1948, made enquiries on my behalf concerning Castelnau, and discovered the portrait of him in the Parisian review "Illustration" in 1847, reproduced here. Amongst residents of the French colony in Melbourne was Madame Crivelli, who came to Australia in 1865.

She remembered Castelnau well and told M. Loubère that the Count had a passion for stuffing birds, and that his Consulate looked like a taxidermist's shop, with dozens of stuffed birds hanging on the walls. She did not, however, mention fishes.

GAMBUSIA, THE FISH DESTROYER

By George S. Myers

About the turn of the century, not long after it was discovered that mosquitoes transmit both malaria and the deadly yellow fever, public health officers and doctors in many parts of the world began to take an interest in reducing or eradicating those diseases by introducing into local waters certain small fishes known to feed on the aquatic larvae of mosquitoes.

American research on mosquito-destroying fishes was concentrated mostly on the mosquitofish, *Gambusia affinis* (and its subspecies, *holbrooki*), and *Gambusia* gradually became known throughout the world as THE fish to introduce in the fight against mosquito-transmitted diseases. Unfortunately, this earlier American research was not as well conceived as it might have been, and it missed several important points. It was pointed out that because *Gambusia* does not normally penetrate thickly matted aquatic plants, such plants must be periodically removed if *Gambusia* is to control mosquito larvae effectively. This is quite true, but it entirely missed the point that other available small fishes penetrate such aquatic plant growths and assist *Gambusia* in controlling mosquito larvae which cannot be reached by *Gambusia*. It was also pointed out that *Gambusia* and similar fishes cannot exist long in temporary ponds which dry up in the dry season, and must be re-introduced when the ponds again fill up with rainwater. And the destructiveness of *Gambusia* to other fishes was simply not recognised.

However, relatively few physicians and health officers were aware of even such research as had been done, and *Gambusia,* because of its success in a few widely scattered countries, gained world renown and was uncritically accepted as a sort of panacea for mosquito troubles. Introductions were made in many new places throughout the world, and they are still being made, despite what we know now about *Gambusia.*

The fact is that *Gambusia* is a very dangerous fish to introduce into a place where it does not occur naturally, and is little or no better as a mosquito destroyer than many other species.

The staff of the California State Fish and Game Department's black-bass hatchery at Friant had to discontinue using *Gambusia* as a "forage fish" with which to feed the bass. *Gambusia* was destroying a large proportion of the young bass! Through the years, such information has slowly accumulated. Almost everywhere that *Gambusia* has been introduced, it has gradually wiped out most or all of the smaller native mosquito-destroying species. It has also almost certainly taken a heavy toll of the young of important larger food or game fishes. And so it goes. No one has yet assessed the damage.

Why should *Gambusia* do this? Why does it not wipe out other small species and affect bass and other larger fishes in its native haunts? The answer lies in what ecologists call, somewhat roughly, "the balance of nature." In our [American] southeastern states, a balance has been evolved through the ages. *Gambusia* is kept from too much destruction by its naturally evolved enemies, and smaller fishes have learned to hide from it. But when placed in a new situation, where natural checks do not occur and native species have evolved no defenses, many introduced species of animals will take over and become pests which crowd out the natural fauna. The introduced house sparrow (English sparrow) in North America is one example. The pest of introduced rabbits in Australia is another. Thus does man's ignorance often destroy what nature has taken millions of years to produce.

(Reprinted, with permission, from part of an article in the *Tropical Fish Hobbyist*, Jersey City, U.S.A.)

[*Gambusia* was introduced to Sydney in 1925 and to Brisbane in 1929, and a year later to New Zealand. Further introductions were made in parts of New South Wales from 1935 onwards. In 1940, *Gambusia* was flown to Darwin and during World War II was spread through military camps in many parts of Australia.—Ed.]

ILLUSTRATIONS AND RECORDS OF FISHES

By Gilbert P. Whitley

(Figures 1-13)

Miscellaneous fishes (mostly of little known, marine, tropical Indo-Pacific species) are described, recorded or figured here, sometimes with remarks on synonymy. The types and other specimens are in the Australian Museum, Sydney, except the blind eel which was kindly lent by the Director of the Western Australian Museum, Perth, to whom my grateful thanks are expressed. Thanks are also tendered to Miss Helen Ashton, my former assistant at the Australian Museum, for drawing most of the illustrations.

Family SYNBRANCHIDAE

Genus ANOMMATOPHASMA Mees, 1962.

ANOMMATOPHASMA CANDIDUM Mees.

(Figure 1.)

Anommatophasma candidum Mees, 1962, J. Roy. Soc. W. Austr. 45:27. *Id.* Cawthorn, 1963, W. Austr. Nat. 8:129.
Id. Whitley, 1964, Freshw. Fish Austr., ed. 2:39, fig.

Here figured from the paratype of the species (W. Austr. Mus. regd. no. P. 4918), kindly lent by the Director of the Western Australian Museum, Perth. A label with the specimen reads, in part, "Water in well 70°. Collected Eel at approx. 4.00 a.m. . . . . Solitary specimen. As with previous specimen it went back under rock at sight ? of light and did not emerge until 1½ hours later."

This genus and species is known only from subterranean fresh waters of North-west Cape, Western Australia.

Family MURAENIDAE.

Genus LYCODONTIS McClelland, 1844.

Lycodontis McClelland, 1844, Calcutta J. Nat. Hist. 5 (18):173. Type-species, *L. literata* McClelland, selected by Jordan & Evermann, 1896, Fish. N. & Middle America 1: 392.

LYCODONTIS SCRIPTUS (Bloch & Schneider).

(Figure 2.)

Gymnothorax scriptus Bloch & Schneider, 1801, Syst. Ichth: 529. *Id.* Richardson, 1843, Rept. 12th meeting Brit. Assn. Adv. Sci. 1842: 28. *Id.* McCulloch, 1929, Austr. Mus. Mem. 5: 72.

This species of reef eel was described in Latin from "Nova Hollandia" more than 160 years ago but has not hitherto been illustrated. Probably because of the vagueness of the type-locality, the species has been omitted from works on New South Wales fishes and even from Munro's Handbook of Australian Fishes, 1957. It is a rare eel, only a few isolated examples of which have been hooked in New South Wales, first in the eighteenth century (the 2ft. long type which probably came from Sydney or Botany Bay), thence as follows:-

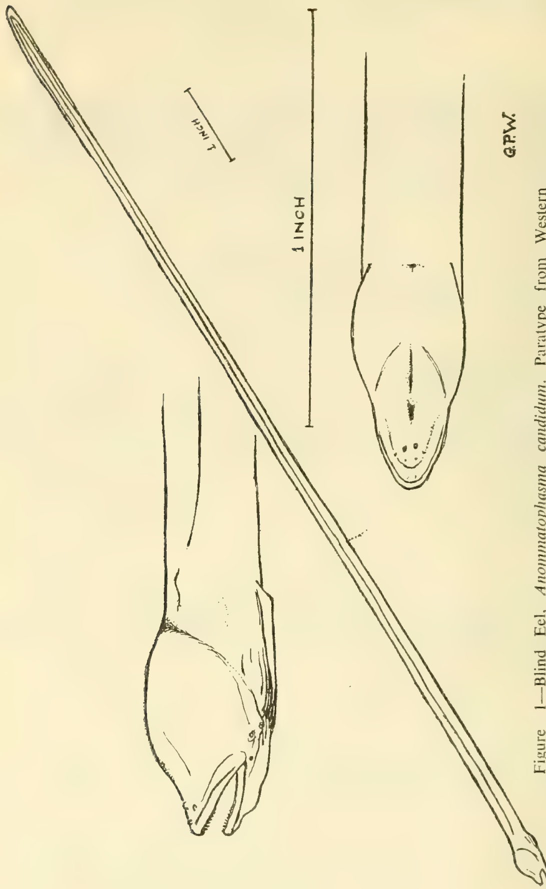


Figure 1—Blind Eel, *Anommatophasma candidum*. Paratype from Western Australia.

Australian Museum Reg. No.	Locality	Date and Captor	Head (mm.)	Depth (mm.)	Trunk (mm.)	Total length (mm.)
IB.3180	Berowra	June 1954 A. J. Whittman	53	20	180	430
IB.5731	Mouth of Hawkesbury River.	28/4/1962. H. Simister.	53	22	172	414
IB.5828	Coal and Candle Creek.	12/8/1962. A. B. Iverach.	52	19	182	375
IB.6349	Hawkesbury River.	Jan. 1963 Mr. King.	38	17	150	350

The last-named specimen is figured here.

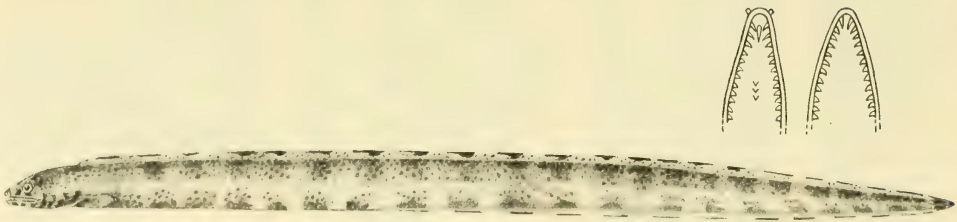


Figure 2—Haan, *Lycodontis scriptus*. New South Wales. Inset: dentition.

The diagnostic characters of the species, which is most easily recognised by its characteristic colour-pattern, are as follows:-

Head 7.2 to 9.2 and depth 18.8 to 21.5 in total length. Head 3.2 to 3.9 in trunk. Anterior nostrils tubular, posterior ones orifices over front of eye. Lips not fimbriate. Teeth compressed, erect canines on jaws, about 12 or 13 on each side of each jaw. No mesial intermaxillary teeth. A row of small blunt molars on vomer posteriorly. Vent in anterior half of fish (preanal length 41.5 to 48% of total).

General ground-colour pale yellow or cream to dirty white below, densely mottled with greyish brown except along middle of belly. A series of seventeen to twenty-one large bruise-like brown marks along lower sides of head and body, becoming bands posteriorly on tail. Anteriorly, these marks are not bilaterally symmetrical and on the chin and sometimes on the belly they break up into smaller blotches. About seventeen to twenty-three blackish areas along the dorsal fin and eleven to fourteen on the anal fin continue from the body bands. Caudal partly cream and partly black. Throat-folds greyish-brown; eye pale blue. Gill-openings and corner of mouth pale. Nostrils yellow. Teeth white, with carmine axial streak.

Grows to 2 feet, according to Bloch & Schneider, who remarked that the aboriginal name for this eel was Haan.

Family ANTHIIDAE.

Genus HYPOPLECTRODES Gill, 1863.

Hypoplectrodes Gill, 1863, Proc. Acad. Nat. Sci. Philad., 1862: 236, footnote. Orthotype, *Plectropoma nigrorubrum* Cuvier & Valenciennes.
Id. Poey, 1871, Ann. N. York Lyc. Nat. Hist. 10: 45.
Id. Gill, 1896, Proc. U.S. Nat. Mus. 18:568.
Id. Ogilby, 1899, Proc. Linn. Soc. N.S.Wales 24:170.

This genus, which appears to have no synonyms, is distinguished from *Ellerkeldia* (*Gilbertia*, preocc.), its nearest ally, by having the lateral line formed of intercalated scales, each of which bears several tubules and has a convoluted edge.

HYPOPLECTRODES NIGRORUBER MACULATUS, subsp. nov.

(Figure 3.)

Plectropoma nigrorubrum Cuvier & Valenciennes, 1828, Hist. Nat. Poiss. 2:402. King George's Sound, Western Australia.
Id. Quoy & Gaimard, 1835, Voy. Astrolabe Zool. 3:659, pl. 4. fig. 1.
Id. Richardson, 1843, Rept. Brit. Assn. Adv. Sci. 1842: 17.
Id. Gunther, 1859, Cat. Fish. Brit. Mus. 1: 158.
Id. Castelnau, 1875, Res. Fish. Australia: 8 and Proc. Linn. Soc. N.S.Wales 3, 1879: 349.
Id. Klunzinger, 1879, Sitzungsb. Akad. Wiss. Wien 80:335.
Id. Macleay, 1881, Proc. Linn. Soc. N.S.Wales 5:322 and Descr. Cat. Fish. Aust. 1, 1881:22.
Id. Ogilby, 1885, Proc. Linn. Soc. N.S.Wales 10: 119 and Cat. Fish. N.S.Wales, 1886: 9, also Edib. Fish. N.S.Wales 1893:11 and Proc. Linn. Soc. N.S.Wales 24, 1899: 170.
Id. Woodward, 1902, W. Austr. Year Book 1900-01: 270.
Gilbertia nigrorubra Boulenger, 1895, Cat. Acanth. Fish. Brit. Mus. (2) 1:307 & 308.
Hypoplectrodes nigroruber Gill, 1896, Proc. U.S. Nat. Mus. 18: 568.
Id. Waite, 1921, Rec. S. Austr. Mus. 2:93, fig. 140 and 1923, Fish. S. Austr. : 116 & fig.

Hypoplectrodes nigrorubrum Waite, 1904, Mem. Nat. Club N.S.Wales: 28.
Id. Stead, 1906, Fish. Austr. 15 & 262.
Id. Stead, 1908, Edib. Fish. N.S.Wales : 59.
Id. McCulloch, 1921, Austr. Zool. 2(2) : 46, pl. 18, fig. 165a.
Id. McCulloch, 1929, Austr. Mus. Mem. 5: 154.
Id. T. Scott, 1962, Fish. S. Austr. : 227, fig.
Gilbertia nigrorubrum Zietz, 1909, Trans. Roy. Soc. S. Austr. 33: 269.
Hypoplectrodes nigrorubrum var. *maculatus* D. G. Stead, MS. label in Australian Museum.

Ogilby (1885) suggested the eastern Australian form of *nigrorubrum* might have to be raised to the rank of a local race or subspecies and D. G. Stead years later invented the manuscript name *Hypoplectrodes nigrorubrum* var. *maculatus* for a specimen from New South Wales. This, the holotype of the new subspecies, agrees with Ogilby's 1893 description in general but has the following special characteristics.

D.ix, 17; A.iii, 8; P.14. L.lat. 54. Tr. 4/1/22 to 4/1/6 on caudal peduncle.

Head (100 mm.) 2.75, length of caudal fin (43) 6.3, height of body (74) 3.7 in total length (275). Eye (18) 5.5 in head and 1.1 in snout (20). Interorbital (7) 2.5 in eye. Longest (third) dorsal spine (29) 3.7, second anal spine (20) 5, ventrals (48) 2, pectorals (67) 1.5 in head. Depth of caudal peduncle (26) 2.8 in that of body.

General characters as described by Ogilby (1893). Gill rakers 2 + 6, short, spatulate. Tongue acute, free.

Colour after long preservation, uniform yellowish-brown. Eye blue. A dark brown blotch, subequal to eye, on each side of body below arch of lateral line.

Described and figured from the holotype of the subspecies, a specimen 225 mm. in standard length or 275 mm. in total length (nearly 11 inches).

Loc.—Tuggerah, New South Wales, 1903, Mr. Gordon per D. G. Stead. Austr. Mus. regd. no. IB.886.

A smaller paratype (no. I. 9953) from off Bondi, New South Wales, and an unregistered specimen with no data have similar coloration to the holotype.

Differs from the nominate species by having a dark blotch below the lateral line instead of five blackish sloping cross-bars on the body.

Family CHAETODONTIDAE
Genus CHAETODON Linne, 1758,
CHAETODON GUNTHERI Ahl.

(Figure 4)

Chaetodon guntheri Ahl., 1923, Archiv Naturges. 89 (A), 5:99. Manado. *Id.* Weber & Beaufort, 1936, Fish. Indo-Austr. Archip. 7:79, fig. 24.
Id. Smith, 1950, Sea Fishes S. Afr. : 239, fig. 604 and 1953, Mem. Mus. Castros, 2:9-10.
Id. Whitley, 1954, Proc. Roy. Zool. Soc. New South Wales 1952/53:23.

The specimen from a fish trap from 20 fathoms, 8 miles off Byron Bay, N.S.W. which I recorded from Australia (Austr. Mus. regd. no. IB.2473) is here illustrated. The species is evidently rare. In alcohol, yellow with dark brown spots, ocular band and inframarginal borders to fins as figured.

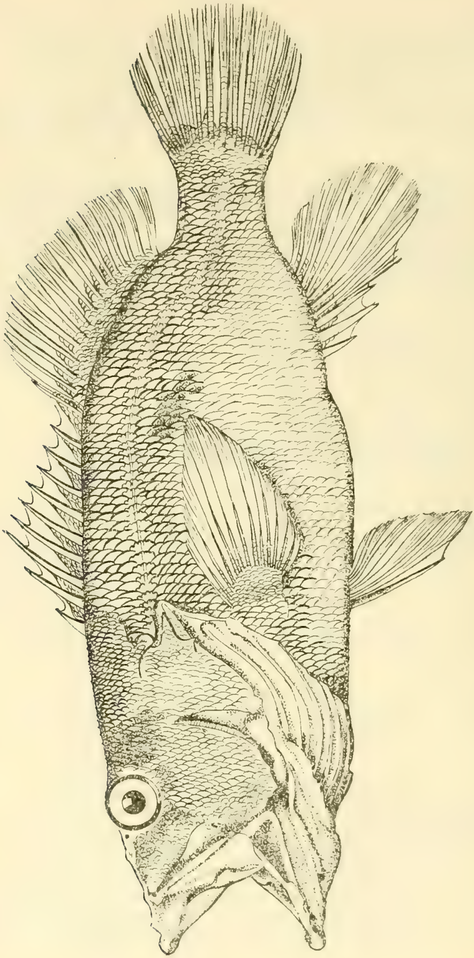


Figure 3—Sea Perch, *Hypoplectrodes nigroruber maculatus.* Holotype of subspecies, New South Wales.

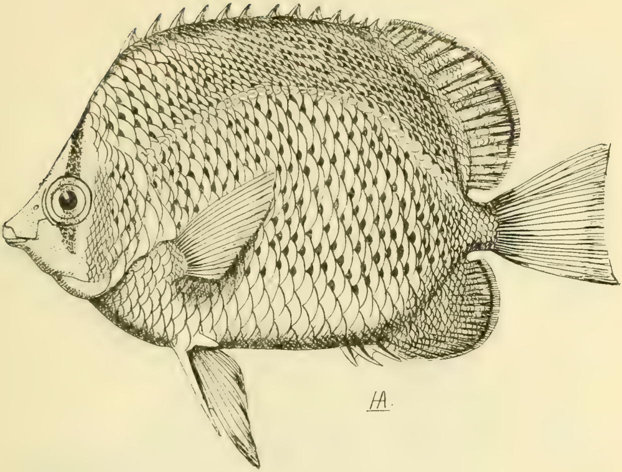


Figure 4—Butterfly Fish, *Chaetodon guntheri.* New South Wales.

Family POMACENTRIDAE

Genus POMACENTRUS Lacépède, 1802.

POMACENTRUS OBREPTUS Whitley.

(Figure 5)

Pomacentrus obreptus Whitley, 1948, Austr. Zool. 11:275.

Here figured from the holotype (Austr. Mus. regd. no. IB.1571) from the Monte Bello Islands, Western Australia.

Family CORIDAE.

Genus OCTOCYNODON Fowler, 1904.

OCTOCYNODON MINIATUS (Cuvier & Valenciennes).

(Figure 6)

Julis miniatus Cuvier & Valenciennes, 1838, Hist. Nat. Poiss. 13, "1839":460, ex Kuhl & van Hasselt, MS. Java.

Pseudojulis maculifer Castelnau, 1875, Res. Fish. Austr. (Vict. Offic. Rec. Philad. Exhib.): 35. Queensland.

A specimen, 52 mm. overall, identified as *Pseudojulis maculifer* many years ago in the Australian Museum (regd. no. I.449) from Cape York, Queensland, agrees with Castelnau's description except that the head goes 3 in standard length and the scales are fewer. It has D.ix, 11; A.iii, 11: L.lat. 28. Canines directed forwards. Thoracic scales not enlarged. Fins without scaly sheaths. Here illustrated.

It is evident that *Pseudojulis maculifer* is a new synonym of *Octocynodon miniatus.*

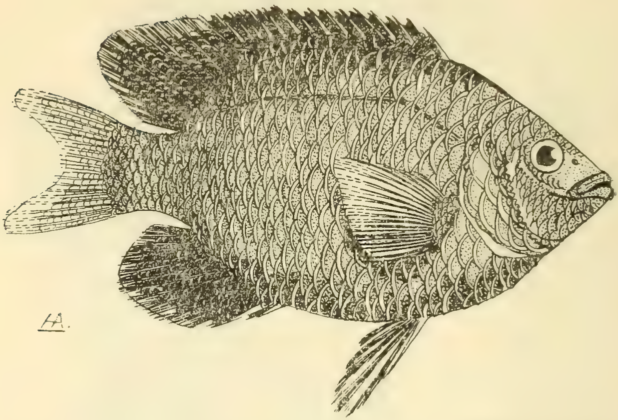


Figure 5—Demoiselle, *Pomacentrus obreptus*. Holotype, Western Australia.

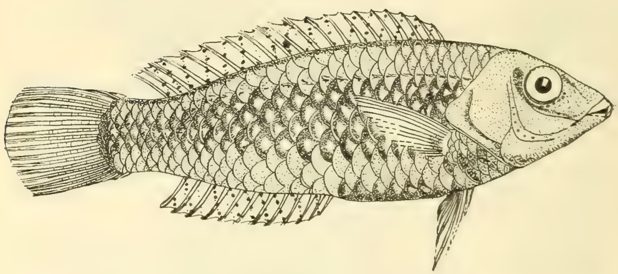


Figure 6—Wrasse, "*Pseudojulis maculifer*" = *Octocynodon miniatus*. Queensland.

Genus HALICHOERES Rüppell, 1835.

HALICHOERES NIGRESCENS (Bloch & Schneider).

(Figure 7)

Labrus nigrescens Bloch & Schneider, 1801, Syst. Ichth. : 263. No. locality (Indonesia.)

Halichoeres nigrescens Fowler & Bean, 1928, Bull. U.S. Nat. Mus. 100 (7):280 (q.v. for refs. & synon.) *Id.* Fowler, 1946, Proc. Acad. Nat. Sci. Philad. 98:166, fig. 33 and 1956, Quart. J. Taiwan Mus. 9:230, fig. 19 (young).

D. ix, 12; A. iii, 12; P.i., 15; L.lat. 27. Tr. 3/1/10 Pred. sc. 12.

Head (25 mm.) equals depth (25) 3.2 in standard length (79). Head naked. Two slightly enlarged non-flaring canines in each jaw anteriorly followed by about seven uniserial teeth. A strong posterior canine each side of upper jaw. Preopercle entire. Body compressed, scaly, scales of thorax not enlarged, those of predorsal areas smallest. Lateral line complete.

Dorsal spines slender, not divergent, regularly increasing in length to the fourth (8 mm.); membranes penicillate. Ventral spine long (8.5 mm.) and slender.

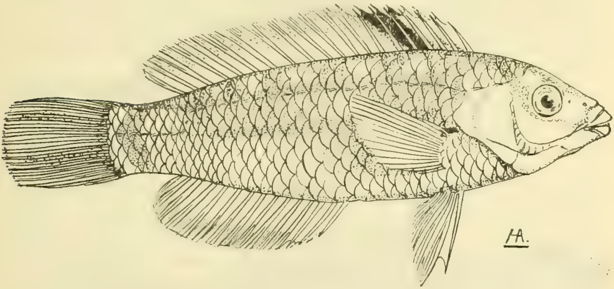


Figure 7—Wrasse, *Halichoeres nigrescens*. Queensland.

Colour after long preservation in alcohol, yellowish-brown with about seven indistinct broad darker brown cross-bars from back to middle of sides where each one is broken up by the intrusion of light centres to scales. A brown oblique bar from eye to before dorsal fin. A milky crescent around hinder and lower orbital rim. Eye greenish-yellow. Teeth whitish. A brown spot at pectoral axil. Fins all yellowish, a dusky brown wash near dorsal base anteriorly, followed by a blackish area on the fifth to seventh dorsal spines and thence continued as a dusky wash along outer half of soft dorsal fin. Anal similar to second dorsal. Other fins yellowish. No ocelli on soft dorsal fin or on caudal base.

Described and figured from a specimen 79 mm. in standard length or 3¾ inches overall. Austr. Mus. regd. no. 1A.620.

Loc.—Holbourne Island, off Port Denison, Queensland. Mr. E. H. Rainford, 1921. New record for Australia.

Family URANOSCOPIDAE.

Genus URANOSCOPUS Linne, 1758.

URANOSCOPUS TERRAE—REGINAE Ogilby

(Figure 8)

Uranoscopus terrae-reginae Ogilby, 1910, New Fish. Qld. Coast: 131. Trawled off south Queensland coastline. *Id.* McCulloch & Whitley, 1925, Mem. Qld. Mus. 8: 174. *Id.* Whitley, 1959, Proc. Roy. Zool. Soc. N. S. Wales 1957-58 : 23. *Id.* Mees, 1960, J. Roy. Soc. W. Austr. 43: 56-57.

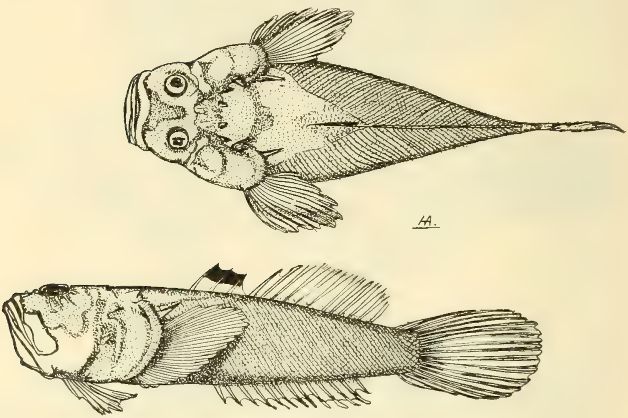


Figure 8—Stargazer, *Uranoscopus terraereginae*. Dorsal and lateral views of lectotype. Queensland.

Here illustrated from the lectotype, largest of a number of specimens trawled off the Queensland Coast. It is registered no. E.2764 and was trawled by F.I.V. "Endeavour", 4 to 20 miles N.E. of Gloucester Head, Queensland in 19 to 35 fathoms on 2nd August, 1910. Total length 7¼ inches (180 mm.) or 148 mm. in standard length.

Family SCORPAENIDAE
Genus SCORPAENOPSIS Heckel, 1837.
SCORPAENOPSIS PALMERI FURNEAUXI Whitley.
(Figure 9)

Scorpaenopsis palmeri furneauxi Whitley, 1959, Proc. Roy. Zool. Soc. N. S. Wales, 1957-58: 24. Off Pine Peak and Hayman Island, Queensland.

Figured from the holotype of the subspecies, the larger of two specimens (E.2896) trawled off Pine Peak, Queensland.

Genus IRACUNDUS Jordan & Evermann, 1903.

Iracundus Jordan & Evermann, 1903, Bull. U.S. Fish. Comm. 22, 1902: 210 *et ibid.,* 23, 1903 (1905): 470, fig. 207. Orthotype, *I. signifer* Jordan & Evermann from Honolulu. *Id.* Fowler, 1928, Mem. Bishop Mus. 10: 292 (references). *Id.* Gosline & Brock, 1960, Handbook Hawaiian Fishes: 286 & 341.

A little-known genus with only one species of which a few Hawaiian specimens are known; most authors copy Jordan & Evermann's account. I collected an example in the Cook Islands which differs in having one more pectoral ray, fewer scales, the maxillary reaching below posterior portion of eye, fewer dermal flaps, no large pores on lower jaw, and longest dorsal ray less than half head. In the type the pectoral rays are described as all simple but Jordan & Evermann's figure shows four divided rays as in my specimen which is described below as a new subspecies.

IRACUNDUS SIGNIFER RAROTONGAE, subsp. nov.

Br.6. D.xi, i, 10; A.iii, 5; P. 18 (2 + 4 branched + 12); V.i, 5; C. 11 branched rays. Sc. 39 above 1. lat. Tr.9/1/21. Predorsal sc.8. L.lat. with about 28 spine-bearing scales. Gill-rakers 6/4 + 6 rudiments on first branchial arch.

Head (37 mm.) 2.4, depth (26) 3.4 in standard length (90). Snout, 10 mm.; eye, 9; interorbital, 4; postorbital part of head, 19; first dorsal spine, 8; fourth (longest) dorsal spine, 22; longest (5th) dorsal ray, 15; second anal spine, 14; length of pectoral, 25, equal to that of caudal, 25; pectoral base, 11; maxillary, 20; depth of its distal extremity, 6.

No deep notch in profiles. No pit below eye. Most of head naked. Scales only on postorbital regions and opercles; including lower part of operculum. Maxillary reaching below posterior part of eye, truncate, smooth. A few small lappets over eye but no supraocular tentacle. Interorbital concave. Coronal ridges weak. Acute teeth in bands on jaws and vomer; none on palatines. They are largest on the posterior row near the symphyses and at each side of the vomer. One strong, sloping nasal spine each side. Preocular, supraocular and postocular spines present. No coronal or postfrontal spines. Tympanic, sphenotic, parietal, nuchal, pterotic, posttemporal, humeral, and postorbital spines present, all simple. Humeral spine without other spiny projections along its length. Suborbital ridge with three spines, the first two recumbent and only the third with salient tip. Two preorbital spines, the second not retrorse but pointing downward. Four, short preopercular spines and two long opercular ones diverging in a curved V. No barbels. Bones of head not cavernous, or with large muciferous cavities. Several large pores below suborbital stay. Pores below head very small. Gill-rakers low, spiny, clavate knobs.

Form rather slender, little compressed, back not humped. Cleithrum naked. Prepectoral region, breast and rest of body scaly. Scales imbricate, adherent, ctenoid, not extending over fins. Some small skinny flaps along l. lat. and sparsely scattered over head and body elsewhere. Lateral line complete, not modified posteriorly, its tubes simple and its course encroached upon by the body-scales.

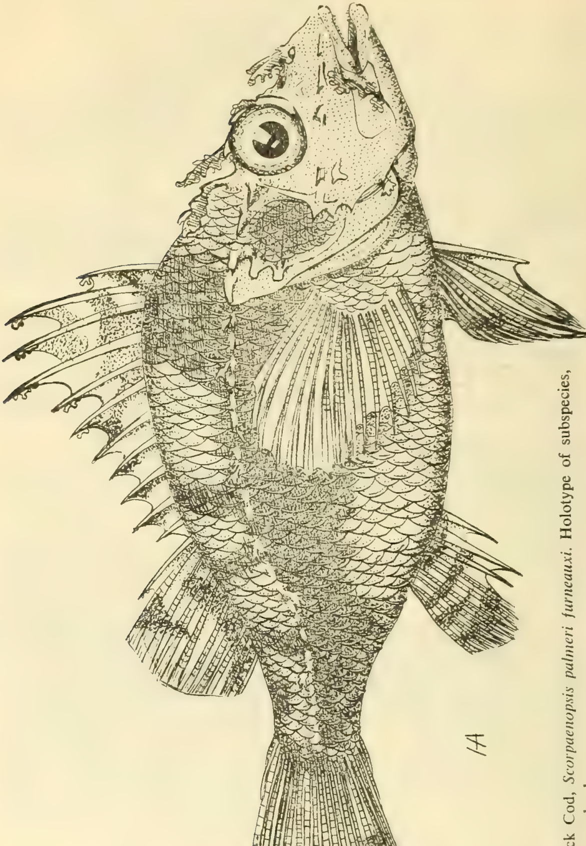


Figure 9—Rock Cod, *Scorpaenopsis palmeri furneauxi*. **Holotype of subspecies, Queensland.**

First dorsal fin beginning over opercular flap, with twelve spines, the fourth produced, membranes not deeply incised. A deep notch between the two dorsal fins. Second anal spine very strong, slightly longer than third. Anal origin below anterior dorsal rays. Third to sixth pectoral rays bifid; ninth ray longest; lowermost ray not detached as a feeler. A slight flap on inner base of pectoral. Ventrals rounded, not nearly reaching vent, which is inconspicuous, before anal fin. Caudal rounded.

Colour now faded to brownish-yellow without any conspicuous markings. Some small white spots on lower parts of head, front of back, and in pectoral axil. Eye beetroot red. A small black mark at base of first dorsal spine and a black blotch between second and third spines. Fins plain.

Described from the unique holotype of the subspecies, 90 mm. in standard length or 4½ inches overall. Australian Museum regd. no. IA.5226.

Loc.—Rarotonga, Cook Islands, Pacific Ocean; collected on coral reef, October or November 1931, by Gilbert P. Whitley.

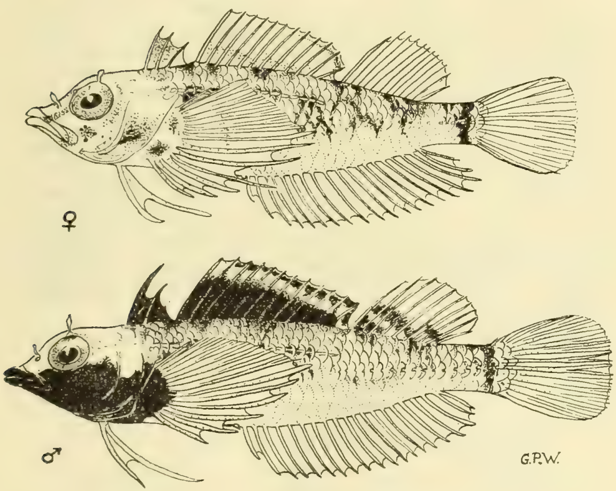


Figure 10—Threefin Blenny, *Vauclusella annulata*. Female, New South Wales.

Figure 11—Threefin Blenny, *Vauclusella annulata*. Male, New South Wales.

Family CLINIDAE.

Genus VAUCLUSELLA Whitley, 1931.

VAUCLUSELLA ANNULATA (Ramsay and Ogilby).

(Figures 10-11)

?Tripterygium atrigulare Gunther, 1873, J. Mus. Godef. 1 (4):91. Bowen, Queensland.

Tripterygium sp. Gunther, 1880, Rept. Zool. Challenger 1 (6): 28. *Id.* Ogilby, 1886, Fish. N. S. Wales: 39.

Tripterygium annulatum Ramsay & Ogilby, 1888, Proc. Linn. Soc. N. S. Wales (2) 2 (4) : 1021 & 1078. Vaucluse, Port Jackson, N. S. Wales.

Tripterygion rufopileum Waite, 1904, Rec. Austr. Mus. 5: 182, pl. 24, fig. 4. Lord Howe Island.

Tripterygion annulatum Waite, 1904, Mem. Nat. Club. N. S. Wales : 52. *Id.* McCulloch, 1922, Austr. Zool. 2 (3) : 114, and of later authors and lists. *Id.* Ogilby, 1915, Mem. Qld. Mus. 3 : 136. *Id.* Fowler, 1957, Ichth. Notes 1 (3): 70. *Id.* Schultz and others, 1960, Bull. U.S. Nat. Mus. 202:293.

Vauclusella annulata Whitley, 1931, Austr. Zool. 6: 324 and 1935, Austr. Mus. Mag. 5: 292.

This opportunity is taken of presenting illustrations of a male (Austr. Mus. regd. no. IB.6862; total length, 46 mm.; standard length, 37.5 mm.) and a female (IB.6863; t.l. 41; s.l. 34) which I collected at Minnie Waters, northern New South Wales on 3rd November, 1963. The male has a black head, the body mostly crimson and with some black on the dorsal fins and as a band down the caudal base. The female is pink with irregular chequers of dark grey; the head is finely dotted, not black.

The types and many other specimens of the species show the following characters:

D. ii-iii/xii-xiii/10-11: last dorsal rays, whether 10th or 11th, always divided. A. 19-20, last two often close together. Third or fourth last anal ray longest. P. 15. C. 13. Sc. 32-34. Tr. 3-5/1/5. L.lat. 16-17 tubes and about 18 pierced scales. A few, low, poorly developed gill-rakers; very fine teeth on jaws.

Maxillary reaches nearer middle of eye in young than in adults; snout straight in young and concave in adults. Breast naked. Total length up to 2 inches.

Besides New South Wales, *annulata* is known from Southern Queensland and Lord Howe Island whence it has been named *Tripterygion rufopileum* Waite, a new synonym of *V. annulata.* It may eventually prove to be synonymous with the tropical Queensland *atrigulare* (*atrogularis* of authors), but the latter typically has fewer anal rays (14), and the posterior portion of the body is sometimes blackish.

Other species have still to be recorded from the Gulf of Carpentaria and Western Australia.

VAUCLUSELLA ACANTHOPS Whitley.

(Figure 12)

Vauclusella acanthops Whitley, 1964, Austr. Nat. 12 (4): 15. Heron Island, Queensland.

D. iii/xvii/8; A. ii, 19; P. 2+7 branched + 7 = 16; V.2; C.10 branched. L.lat. 16 tubes and about 21 notched scales. Sc. 36. Tr. 2 to 3/1/5 or 6.

Head (10 mm.) 3.4, depth (7) nearly 5 in standard length (34). Eye, 3 mm.; snout, 2; longest (tenth) pectoral ray, 13; depth of caudal peduncle, 3; predorsal length, 8; first dorsal spine, nearly 5; length of caudal fin, 9 mm.

Facies are figured: a slender fish with longer caudal fin than usual in the genus.

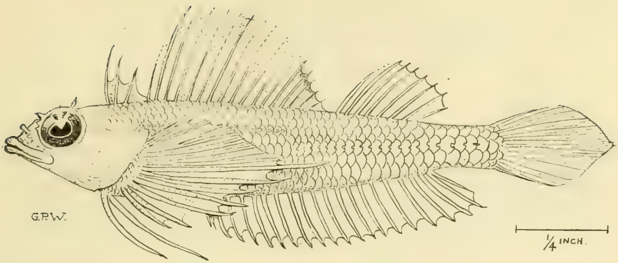


Figure 12—Threefin Blenny, *Vauclusella acanthops*. Holotype, Queensland.

Head naked except on nape, Snout steep and conic.

Maxilla reaching below middle of eye. Teeth small, conic.

Three conical spines over front of each eye. A supraorbital and a nasal tentacle. Interorbital narrow and concave between the raised, minutely denticulate orbital rims.

No predorsal scales.

Body, including breast, nape and pectoral base, with deciduous, imbricate, ctenoid scales.

Three dorsal fins, the second higher with 17 spines. Anal origin below seventh spine of second dorsal fin, its base ending well behind that of third dorsal. Two slender anal spines, close together, shorter than the rays, the last of which is divided to its base. Pectoral reaching below third dorsal fin. Membrane of ventral fin not evident. Caudal long, convex, subequal to head without snout.

Colour in preservative, plain greyish brown; no dark blotches. Spinous dorsal fins infuscated.

Described and figured from the holotype of the species, a specimen 42 mm. or 1⅝ inches overall. Australian Museum registered no. IB.4016.

Five paratypes (Nos. IB.4023 and 4028) show no important variation. The ocular spines are just evident in a 34 mm. fish, the smallest specimen. The spines of the second dorsal fin vary from 16 to 17. A.ii, 19-20; P. 15-16; Sc. 34-37; L.lat. with 16 to 18 tubes. Tr. 2-3/1/5-7.

Loc.—Heron Island, Queensland; 1957. Presented by Mr. R. Slack-Smith who gave the holotype his field number 40/9/4. The paratypes, with same data, have field nos. 46/26/3 and H.98 Spec. C.

Readily distinguished from its congeners by its scaleless head, orbital spines, scaly breast, long caudal and pectoral fins, and 16 or 17 spines in the second dorsal fin.

Family SALARIIDAE.

Genus SALARIAS Cuvier, 1816.

SALARIAS RAROTONGENSIS, sp. nov.

(Figure 13)

D.xii/15; A. 17; P. 14; V. 3. C. with 7 branched rays.

Head (10 mm.) 4.2, depth (7) 6 in standard length (42). Snout (4) 2.5 in head. Eye (3) 1.3 in snout and 3 times interorbital. Width of mouth (4.5) 2.2 in head.

Head much longer than wide. No nuchal crest. Eyes with a simple tentacle. A very small, simple nuchal tentacle, and a broader, fringed nasal one. Interorbital slightly concave. Maxillary reaches to below posterior part of eye. Both lips entire. Teeth very fine and numerous, flexible. A large canine

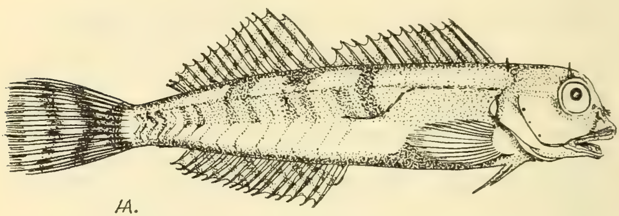


Figure 13—Blenny, *Salarias rarotongensis.* Holotype from the Cook Islands.

on each side behind lower jaw. Gill-membrane with free fold across broad isthmus. Lateral line arched above pectoral, obsolete posteriorly. Depth of caudal peduncle equals eye.

Height of first dorsal fin less than that of second which is higher than anal. Dorsals notched to base. Last anal ray and last dorsal ray free from caudal peduncle.

Colour in alcohol pale grey to silvery grey. Vertex of head brown. A series of four paired bands along back, below and slightly behind which are paired brown chevrons along the sides. Scattered brown spots on shoulders and a few on sides of head. Chin slightly fuscous medially and with two indistinct oblique bands on each side of whitish median area. Fins yellowish. Dorsals with reddish-brown spotting. Pectoral not black-spotted, but infuscated towards tip. Caudal with brown marks, mostly on the rays, tending to form sloping cross-bars. Anal border dusky. Eye blue with silvery iris. Upper lip with five transverse dusky bars.

Described and figured from the unique holotype, 50 mm. or nearly 2 inches long. Austr. Mus. regd. no. IA.5358.

Loc.—Rarotonga, Cook Islands; G. P. Whitley, October or November 1931, on coral reef.

Distinguished by its coloration, minute teeth, entire lips, simple ocular and nuchal tentacles.

Family OSTRACIONTIDAE.

Genus ACANTHOSTRACION Bleeker, 1865.

Acanthostracion Bleeker, 1865, Atlas Ichth. 5: 28. Type-species, *Ostracion quadricornis* Linne, by original designation. *Id.* Bleeker, 1865, Ned. Tijdschr. Dierk. 2:301 *et ibid.*, 1866, 3: 5. *Id.* Breder & Clark, 1947, Bull. Amer. Mus. Nat. Hist. 88 (5): 299, pl. 14, text-fig. 4. *Id.* Smith, 1950, Sea Fishes S. Africa: 411, pl. 92, fig. 1173.

ACANTHOSTRACION BUCEPHALUS, sp. nov.

D.11; A.11; P.11; C.8. Sc.9. Tr.9.

Head (18mm.) 3.8, depth (37) 1.8 in standard length (69). Eye (9 mm.) 1.5 in snout (14). Pectoral fin at least 13 mm. long. Caudal peduncle long (15 mm. from end of carapace at sides to root of tail). Gill-opening (7 mm.), below posterior half of eye. Anterior profile very steep; cheeks deep. Interorbital very concave. Teeth brown, spaced, peg-like, few in each jaw. Nostrils near eyes.

A forwardly and outwardly directed spine just before each eye. Carapace closed behind the dorsal and anal fins and ending in a strong spine above and below. Caudal peduncle without bony plates except for a small round one below the spine behind the dorsal fin.

Dorsal ridge begins on interorbital and extends as a high, very convex crest to the dorsal fin. Lateral ridges obsolete; lateral line faint. Pelvic ridges well developed, extending from below cheeks to a spine behind the closure of the carapace behind the anal fin; they are armed with one strong, backwardly directed spine below the front of the dorsal fin. No median ventral ridge. Dorsal and anal fins higher than horizontal eye-diameter. Some pectoral and caudal rays branched.

Colour pale yellow to yellowish-brown. Ventral surface plain yellow except for few, faint, peripheral grey smudges. Lips, eyes, cheeks, sides and back of body, and caudal peduncle with large, spaced bluish-grey blotches, oval or of irregular shape. Fins mostly yellowish.

Described from the holotype, a dry specimen 69 mm. in standard length or 3½ inches overall.

Loc.—Cooktown district, Queensland. Presented by Mr. S. Kellner, 1963. Australian Museum regd. no. IB.6355.

Comes down to *Acanthostracion* in the key of Fraser-Brunner (1935, Ann. Mag. Nat. Hist. (10) 16: 317 and 320, fig. iv) and differs from the type-species of that genus in its remarkable curved and elevated dorsal ridge, without a prominent spine in the middle of the back, combined with the two ocular spines and the median spine at end of carapace above and below. This genus and its type-species appear to be very little known and one must delve in the earliest systematic works on ichthyology to elucidate relationships.

Ostracion tricornis and *quadricornis* Linne (1758, Syst. Nat., ed. 10: 331 and ed. 12, 1766: 408) are both based on Artedi's gen. 56, syn. 85, a boxfish from "India", *tricornis* having line-priority. Some of Artedi's species were based on boxfishes which he had seen in London taverns ("Vidi Londini in the White Bear" or "Vidi apud Sir Hans Sloane & in Naggshead" and "Vidi Londini in the green Dragon in Stepney," for example) so the types, which may have been from the West Indies rather than "India", probably no longer exist. There is no similar species in Day's "Fishes of India."

The *"Piscis triangularis cornibus carens Clusy"* of Willughby (1686, Historia Piscium 4: 149 and appendix: 20, pl.I,13, fig.2) is similar but lacks the ocular spines. Willughby's *"Piscis triangularis cornutus, cuj media cauda cutacea aculeus perlongus erigitur"* (1686, *loc.cit.* (not in text), pl. I. 15) differs in lacking the long median posterior spines at the ends of the carapace; its erect flap of skin on the caudal peduncle may have been artificial or due to injury.

Genus OSTRACION Linne, 1758.

OSTRACION TUBERCULATUS Linne, 1758.

A young example, 1¾ inches long (Austr. Mus. regd. no. IB. 893) from Jibbon Beach, Port Hacking, 4 July 1907 (Mr. F. Aldrich) had been given a new specific name by D. G. Stead in manuscript. There is no need to publish this name because the fish is evidently *tuberculatus* Linne, a tropical species which occasionally wanders into New South Wales although this is the first record of it from this State. It has the following characters:—

Snout not projecting. Sides flaring outwards below. Carapace four-angled, closed behind dorsal and anal fins. Back and belly convex. No dorsal ridge but one scale protrudes slightly before dorsal fin. Lateral ridge rounded, extends from eye to upper end of carapace. Pelvic ridge similar from below head to near lower end of carapace and extending well behind level of vent. No ventral or medio-lateral ridges. No preopercular or pelvic spines.

New record for New South Wales.

THE SYSTEMATIC STATUS OF CERTAIN AUSTRALIAN LIZARDS OF THE FAMILY GEKKONIDAE

By Arnold G. Kluge

As a result of detailed systematic studies on many of the Australian genera of gekkos (1962a, 1962b, 1963a, 1963b, 1963c, 1963d, 1965, Dixon and Kluge, 1964) which I started as a Fulbright Scholar at the University of Western Australia, Perth, in 1961-2, I have begun to prepare an annotated check-list and key to the species of the Gekkonidae from that continent. I have attempted to examine all of the type series of gekkos supposedly endemic to Australia with the hope that the list will be more useful and accurate systematically when published. As a result of studying many of the type series, systematic problems have arisen which require a taxonomic change and a lengthy discussion which would not be advisable to include in a brief annotated list. The following discussion is an attempt to point out some of these taxonomic problems and when possible to make the necessary systematic changes, as I have done previously (1963c).

I wish to thank Dr. James R. Dixon for bringing to my attention the problem associated with *Phyllodactylus barbouri*, and Mr. Jean Guibé of the Museé National d'Histoire Naturelle, Paris (P.M.) who permitted me to examine the holotype and only known specimen of that species. I am indebted to Miss Alice G. C. Grandison of the British Museum of Natural History (B.M.) for her many courtesies during my stay in London in 1964 and for the opportunity to examine type material under her supervision. I am also greatly indebted to Mr. W. D. Haacke and Dr. Vivien F. FitzSimons of the Transvaal Museum (T.M.) for information on *Peropus pusillus*, and Dr. James E. Böhlke of the Academy of Natural Sciences of Philadelphia (A.N.S.P.) for allowing me to examine the holotype of *Pentadactylus brunneus*. Mr. Harold G. Cogger of the Australian Museum, Sydney (A.M.) and Dr. Ernest E. Williams of the Museum of Comparative Zoölogy, at Harvard University (M.C.Z.) have been very helpful in supplying me with information for this study. I also wish to thank them for the many opportunities to examine specimens in their collections.

Phyllodactylus barbouri Angel = *Diplodactylus vittatus* Gray.

Diplodactylus vittatus Gray, 1832, Proc. Zool Soc. London, p. 40.
Phyllodactylus barbouri Angel, 1936, Bull. Soc. Zool. France, vol. 61, p. 508.

During the summer of 1964 I examined the holotypes of *Diplodactylus vittatus* (B.M. 1946.9.7.43) and *Phyllodactylus barbouri* (P.M. 5600). The two specimens are identical in all important external morphological diagnostic characters (Kluge, 1965). A stereoscopic low voltage X-ray of the holotype of *P. barbouri* was taken and compared with a large series of cleared and stained *D. vittatus;* the skeletal similarities also indicate that the two species are conspecific. Angel's unique specimen of *P. barbouri* is without original locality data and he presumed that it was collected in Madagascar. The incorrect locality information probably explains why Angel did not compare the specimen of *P. barbouri* with material of the common, wide-spread, Australian endemic *D. vittatus*.

Phyria punctulata Gray, *nomen dubium*.

In 1842 Gray described *Phyria punctulata* as a new genus and species of gekkonid lizard from Port Essington (early settlement on Cobourg Peninsula), *Phyria punctulata* Gray, 1842, Zool. Misc., p. 53.

Northern Territory, Australia. Gray's original description of the species was very brief and he failed to mention either the genus or species in his comprehensive lizard catalogue of 1845, and in a survey of the Australian reptile fauna (1867). Boulenger (1885, p. 228) stated that he was unable to locate the type specimen in the British Museum of Natural History collection where it was most likely deposited and he treated *P. punctulata* as a species *incertae sedis*. During the summer of 1964 I was also unsuccessful in locating Gray's original material in the British Museum's collections. There does not appear to be any record of the holotype in the museum's specimen registers and it seems likely that the specimen has been lost.

Gray (1842) suggested that *Phyria* was closely related to *Ptyodactylus* (south-western Asia through northern Africa), but this seems unlikely in view of the differences in the digital characters which he described, and the locality of the specimen (Port Essington, Australia). Chrapliwy, Smith and Grant (1961), with hesitation, referred *P. punctulata* to the synonymy of the Australian endemic *Gehyra australis*. Some of the characters which Gray used in the description of *Phyria* (i.e. two series of diverging subdigital lamellae and ventral surfaces yellow) cast some doubt on his species being synonymous with *G. australis*, and I believe that *P. punctulata* is better treated as a *nomen dubium*.

Goniodactylus australis Gray = *Phyllodactylus marmoratus* (Gray).

Diplodactylus marmoratus Gray, 1845, Cat. lizards British Mus., p. 149.
Goniodactylus australis Gray, 1845, Cat. lizards British Mus., p. 172.

Gray noted only a single discoloured specimen in his original description of *Goniodactylus australis* (1845) which he indicated was from Mr. W. (Walter) Buchanan's collection and which was collected in "*Australia*." Boulenger (1885, p. 72) noted that two specimens formed the type series and that he was only able tentatively to refer Gray's species to the genus *Gonatodes* because "they (the types) are in too bad a state to be determinable." I have examined the holotype of *Goniodactylus australis* (B.M. xxi.86a) and an additional juvenile specimen with it in the same bottle (apparently explaining Boulenger's reference to two specimens) which are indicated on the label as having been purchased from Mr. Buchanan and collected in W. Australia (= Western Australia). Although these specimens are poorly preserved, they clearly exhibit all of the diagnostic characters of *Pnyllodactylus marmoratus* (i.e. long slender digits; single row of enlarged sub-digital lamellae; large subapical plates on digits; dorsal body scalation homogeneous; subcaudal scales undifferentiated; preanal pores absent; dorsal surfaces light brown with darker marbling). The holotype of *G. australis* was compared directly with the type series of *P. marmoratus* (B.M. xxi. 9a-d from Houtman Abrolhos, Western Australia, collected by Mr. John Gilbert and B.M. 58.10.16.94 from "Australia", no collector given) and with more recently collected material of that species. There are no characters, as indicated in the original descriptions of the two species or as taken directly from the type series, which contradict the conclusion that *G. australis* and *P. marmoratus* are conspecific. It is difficult to understand how Gray could have overlooked the *Phyllodactylus*-type of digits of *G. australis*, unless the desiccated nature of the specimens obscured the terminal enlarged lamellae, as is somewhat the case today.

Oedura verrillii Cope, *nomen dubium*.

Oedura verrillii Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 20, p. 318.

In 1957, Cogger published an excellent review of the endemic Australian genus *Oedura;* however, he failed to mention the nominal form *O. verrillii*. This species was described by Cope (1868) from a single tail-less specimen from "Australia", and in general it has been overlooked. The holotype was listed by Cope as no. 724 Museum of Comparative Zoölogy. No. 724 also included a specimen of the Australian endemic *Diplodactylus* (= *Phyllodactylus*) *marmoratus*. An exhaustive search of the M.C.Z. herpetological collections by

both Dr. Ernest E. Williams, the curator, and myself has failed to reveal such a numbered specimen which agrees with Cope's description; presumably the holotype was not returned to the M.C.Z. and has been lost. The specimens loaned to Cope for study do not appear to have had authentic M.C.Z. numbers in most cases (Dr. Ernest E. Williams, personal communication), but instead were those of the collector or of another museum. These numbers are often entered alongside those of the M.C.Z. in the present catalogues of the museum. Barbour and Loveridge (1929) in their checklist of the type material in the Museum of Comparative Zoölogy allude to these numbers as being from an early M.C.Z. specimen catalogue; however, this does not appear to be the case.

Although Cope's description of *O. verrillii* is quite brief it seems likely that the species was correctly referred to the genus *Oedura* (*viz.* the presence of an arched series of femoral pores and the type of subdigital lamellae). The brevity of the description and the inclusion of some confusing statements such as "two rows of infralabials across chin" and "thoracic and ventral flat, larger than the flat dorsals" does not permit a more specific identification in the absence of the holotype. Cope's species must therefore be considered a *nomen dubium*.

Peropus pusillus Cope, *nomen dubium*.

Peropus pusillus Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 20, p. 319.

Cope (1868) described the species *Peropus pusillus* from a single specimen (no. 407 Mus. Peabody Acad.) which was stated as having been collected in "S.W. Australia." Boulenger (1885) later referred Cope's species to the genus *Lepidodactylus*. Loveridge (1934, p. 303) noted that M.C.Z. 5735 (not 5725 as stated by Loveridge, which apparently was a typographical error; M.C.Z. 5725 is listed as *Hemidactylus platycephalus* from Zanzibar) was supposed to be the holotype of *P. pusillus*. M.C.Z. 5735 was originally listed in the catalogue as a *Diplodactylus* bearing an apparently unpublished manuscript name of Cope's and the redetermination as *Peropus pusillus* was made by Dr. Thomas Barbour, an earlier curator and director of the museum, as indicated by his handwriting. There is no suggestion as to why Barbour regarded the specimen as the Cope type except that it is from the Peabody Museum, Salem and from S.W. Australia. The Peabody Museum number is entered as "402". Perhaps Barbour thought that either Cope or the cataloguer misinterpreted the Peabody number 407. Barbour and Loveridge (1929) considered M.C.Z. 5735 as the holotype of *P. pusillus*. Loveridge (1934) noted that Cope's description of *P. pusillus* had little in common with M.C.Z. 5735 which was said to be a specimen of *Diplodactylus spinigerus* (see Barbour and Loveridge, 1929). To complicate the problem further, M.C.Z. 5735 was exchanged to the Transvaal Museum (T.M. 21148) by Loveridge. Mr. W. D. Haacke and Dr. Vivien FitzSimons of the Transvaal Museum have been kind enough to reconfirm Loveridge's earlier conclusion that M.C.Z. 5735 is a typical specimen of *D. spinigerus* and has little in common with Cope's original description of *P. pusillus*.

Because of Cope's brief description, which lacks important diagnostic characters, and because the holotype is no longer extant, I consider *Peropus pusillus* to be a *nomen dubium*.

Pentadactylus brunneus Cope = *Hoplodactylus pacificus* (Gray).

Naultinus pacificus Gray, 1842, Zool. Misc., p. 53.
Pentadactylus brunneus Cope, 1868, Proc. Acad. Nat. Sci. Philadelphia, vol. 20, p. 320.

In 1868, Cope described *Pentadactylus brunneus* from a single specimen which he stated was obtained in an exchange from the Musée Jardin des Plantes, Paris, and was considered at that time as having been collected in "Australia" (no specific locality was given). Boulenger (1885) referred

Cope's species to the genus *Aelurosaurus* with some hesitation apparently because of the limited original description, which he quoted in full. It appears that since Boulenger's initial reference to *P. brunneus,* the species has been mentioned in the literature on only three separate occasions. Woodward (1900-1) included *P. brunneus* in his list of reptiles from Western Australia as did Zietz (1920); it seems that both authors followed Boulenger's action (1885) and did not actually have new material which was referable to *P. brunneus.* Barbour and Loveridge (1929) stated that the holotype of *P. brunneus* might have been deposited in the Museum of Comparative Zoölogy, at Harvard University. It was generally agreed at that time that the unique specimen had been lost.

A.N.S.P. 7385 is listed as the holotype of *P. brunneus.* The label associated with the specimen indicates New Holland (= western and central Australia) as its place of collection; the fact that it was acquired from the Jardin des Plantes in exchange during the year 1868 is also noted on the label. The specimen is well preserved but the color and color pattern have faded to a nearly uniform light brown; there is a slight indication of darker brown blotches. A.N.S.P. 7385 agrees with Cope's original description in all characters except the following: (1) the rostral slightly touches the margin of the nostril on both sides — not excluded from the nostril as stated by Cope, (2) the "infralabials" (= postmentals) are scattered irregularly — not in rows as stated by Cope, and (3) one or two supraciliary spines stand out slightly from the rest — Cope noted that they were absent. In spite of these few minor differences, I believe it is reasonable to assume that A.N.S.P. 7385 is the specimen used by Cope for the original description of *P. brunneus.*

The holotype of *P. brunneus* compares favourably with the description of *Hoplodactylus pacificus* (Gray) given by McCann in his recent revision of the genus (1955) and is nearly identical with specimens listed as that species in the collections of the Museum of Comparative Zoölogy, the American Museum of Natural History, and the Academy of Natural Sciences, Philadelphia. On the basis of their similarity I believe it is reasonable to consider *P. brunneus* as conspecific with *H. pacificus* and that the locality information for the former species (Australia) is incorrect; *H. pacificus* is known only from New Zealand.

Heteronota walshi Kinghorn = *Phyllurus sphyrurus* (Ogilby).

Gymnodactylus sphyrurus Ogilby, 1892, Rec. Australian Mus., vol. 2, p. 6.
Heteronota walshi Kinghorn, 1931, Rec. Australian Mus., vol. 18, p. 268.

Kinghorn's type series of *Heteronota walshi* (A.M. R10266, holotype — Boggabri, New South Wales; A.M. R6772-3, paratypes — no locality data) has been examined and compared with the holotype (A.M. R3800) of *Phyllurus sphyrurus* from the "interior of New South Wales (Tumut?)". The two are identical in morphology and are almost certainly conspecific. *Heteronota* and *Phyllurus* are not closely related genera (Kluge, 1965). It appears likely that it was only the superficial similarity of their digits that led Kinghorn to place his material wrongly in the former genus and consider it representative of an undescribed species.

LITERATURE CITED

Barbour, T. and A. Loveridge, 1929. — Typical reptiles and amphibians. *Bull. Mus. Comp. Zoöl.* 69:205-360.

Boulenger, G. A., 1885. — *Catalogue of the lizards in the British Museum* (*Natural History*). 2nd ed., London: Taylor and Francis 1:1-436.

Chrapliwy, P. S., H. M. Smith and C. Grant, 1961. — Systematic status of the geckonid lizard genera *Gehyra, Peropus, Hoplodactylus* and *Naultinus*. *Herpetologica* 17:5-12.

Cogger, H. G., 1957. — Investigations in the gekkonid genus *Oedura* Gray. *Proc. Linnean Soc. New South Wales* 82:167-79.

Cope, E. D., 1868. — Observations on reptiles of the Old World. *Proc. Acad. Nat. Sci. Philadelphia* 20:316-23.

Dixon, J. R. and A. G. Kluge, 1964. — A new gekkonid lizard genus from Australia. *Copeia* 1:174-80.

Gray, J. E., 1842. — *Zoological Miscellany*. London, 2-5:41-80.

——— 1845. — *Catalogue of the specimens of lizards in the collection of the British Museum*. London: Edward Newman, 289 p.

——— 1867. — *The lizards of Australia and New Zealand in the collection of the British Museum*. London: Bernard Quaritch, 7 p.

Kluge, A. G., 1962a. — A new species of gekkonid lizard, genus *Diplodactylus*, from the Carnarvon Region, Western Australia. *Western Australian Nat.* 8:73-5.

——— 1962b. — A new species of gekkonid lizard, genus *Diplodactylus* Gray, from the southern interior of Western Australia. *Western Australian Nat.* 8:97-101.

——— 1963a. — A review of the gekkonid lizard genus *Heteronota* Gray, with a description of a new species from Western Australia. *Journ. Roy. Soc. Western Australia* 46:63-7.

——— 1963b. — Three new species of the gekkonid lizard genus *Diplodactylus* Gray from Australia. *Rec. South Australian Mus.* 14:545-53.

——— 1963c. — The systematic status of certain Australian and New Guinean gekkonid lizards. *Mem. Queensland Mus.* 14:77-86.

——— 1963d. — A new species of gekkonid lizard, genus *Diplodactylus* Gray, from Eastern Australia. *Proc. Linnean Soc. New South Wales* 88:230-4.

——— 1965. — The Australian gekkonid lizard genus *Diplodactylus* Gray: an evolutionary and zoogeographical study. Doctoral Dissertation, University of Southern California xvi + 472 p.

Loveridge, A., 1934. — Australian reptiles in the Museum of Comparative Zoölogy, Cambridge, Massachusetts *Bull. Mus. Comp. Zoöl.* 77:243-383.

McCann, C., 1955. — The lizards of New Zealand, Gekkonidae and Scincidae. *Dominion Mus. Bull.* 17:127 p.

Woodward, B. H., 1900-1. — Natural History of Western Australia. In *Western Australian Yearbook*, 1900-01.

Zietz, F. R., 1920. — Catalogue of Australian lizards. *Rec. South Australian Mus.* 1:181-228.

NOTES ON A PIGMY POSSUM, **CERCARTETUS NANUS** DESMAREST

By Christine Perrers
(Communicated by Melbourne Ward)

(The following notes by Miss Perrers relate to a marsupial kept as a pet in the Blue Mountains, New South Wales, for eight years, a record life-span for the species, which normally feeds extensively on insects in captivity.)

"He was found (in Woodford) on October 17, 1957 and was one inch in length at the time. His ears were flat against his head but eyes were prominent as they have always been. He died on January 28, 1965 and had for the last 12 months looked more aged. The fur on his tail apeared to be rubbing off. His tail curled around any object it came in contact with.

Diet—The possum's diet consisted of rolled oats, cereals, tea leaves, arrow-root biscuit, bread, dates, nuts, pumpkin seeds, cake (not fruit cake), jam, honey, fresh fruit in season, cod-liver oil, charcoal, water, honeysuckle and gum blossoms, honey flower. In early years he had a fondness for sweet food such as cake or jams, but in later years changed to bread and biscuit. The biscuit he would hold between his front paws, standing on his back legs, while eating. He also grew fonder of fruit. He liked white grapes better than black. He did not like any kind of meat, would not eat moths, flies (dead or alive) and was terrified of ants. For the first few weeks after he was found, he was fed on milk, cod-liver oil and malt from an eye dropper. He became quite accustomed to this and would hold the eye dropper between his front paws, while his tongue darted in and out.

Habitat—He was kept in a meat safe, 16" x 16" x 16", inside which was a carrying box (9" x 5" x 6"), for white mice and inside that was a woollen egg cosy and a warm cloth. The safe and box were both lined on the bottom with clean newspaper every day. There was also a small log in this safe. He either slept in the white mice box or the log. In the box he curled around in the egg cosy. Fresh branches of gum leaves and wild flowers were put in the safe. He would sometimes sleep in amongst the leaves. The safe was kept in the bathroom, so that it would be away from our cats. When the weather was hot, we would hang the white mice box on a hook on the verandah during the daytime as he slept. After such an airing he would always be much livelier. He used to tear up the newspaper in the safe to make a nest.

Hibernation—For the first few winters he hibernated for a month or two. This was not a continuous hibernation for this time. The later years he hibernated at odd times in winter for a few days. Before he hibernated we noticed a large swelling at the base of his tail and believed this was his food supply.

Habits—He had a very good temperament but if awakened during the day time would make peculiar grunting noises and screw up his nose in a disgusted look. If shown to strangers, he would get very nervous and tremble. He was sometimes very friendly to us and would run up and down our arms, but at other times would seem to "hide" from us. He was very clean. Sometimes the water would be splashed over the paper as though he had had a bath, but at no time did we find his fur wet. He sometimes drank quite a lot from his water dish."

Notes on Marine Ecology of Lindeman Island, Queensland, with Special Reference to the Brachyuran Crabs

By Melbourne Ward

The essay here presented represents observations on the marine life of Lindeman Island in the Whitsunday Passage, Queensland, made during my residence on that island during the years from 1933 to 1935. The material of the species mentioned, with exceptions of the *Ovula ovum* and the many species of alcyonarian corals which were too large for preservation, are housed in the collection at the Gallery of Natural History and Native Art at Medlow Bath, New South Wales. For the identifications of the echinoderms mentioned I am indebted to the late Hubert Lyman Clark who kindly undertook their examination and returned the material identified when I first brought the collection south. I regret the somewhat fragmentary condition of the notes but I left the locality before they could be properly concluded. Some of the ecological zones which I was able to study have not been reported on in these notes, and I would like to remark that during the stay at the island I had built up a representative library on marine invertebrates with the hope that a permanent research laboratory and library might be established.

The eastern coast of Queensland supports two distinct faunal areas, one confined to the mainland and adjacent islands, the second to the coral reefs of the great barrier chain. Where conditions favour madreporarian reefs, an associated fauna of crabs is to be found; McCulloch first observed this at Rat Island, Port Curtis. My own observations at North West Island and Lindeman Island have proven this distinction of faunas, the latter on account of its close approximation to the mainland and its sharply contrasted zones has a much richer and more varied series.

Lindeman Island lies at the southern end of the Whitsunday Passage and is about eight miles from the mainland. It is approximately five square miles in size and is a high mainland island. The southern shores face Kennedy Sound and are boulder strewn except for two sandy beaches, one at the western and the other toward the eastern end of the island. These sandy beaches impinge upon dead reef flats which in turn are fringed by vigorous madreporarian reefs.

On the northwestern side of the island deeply curved bays are formed and are floored with sand and patches of fine mud, at low water these bays dry out beyond the headlands where the flats slope gently to deep water and are covered with Thalassia and other marine plants on the areas exposed at low tide. This Thalassia region is bounded on the seaward side by a ridge of corals which differ from those found on the southern side of the island in being mainland types such as *Turbinaria*, massive sarcophytons and meandrines, with only a few madrepores.

Lying close to the north western end of Lindeman is a small island known as Little Lindeman and the two are connected by a narrow isthmus which dries at low water springs and forms the richest collecting ground in the region. The northern side of the island from the isthmus along to the eastern extremity presents a series of rugged headlands at the base of which points of rock jut out into the sea, these have sheer seaward faces. The beaches on the northern side of the island are composed of shingles, dead coral reefs occur at the western end of the island, but at the eastern end the shingle beaches slope steeply to deep water. The sheer rocky points have become covered by extensive clusters of oysters and barnacles.

Most of the bays on the western and north western side of the island have mangroves though they are not extensively developed.

The notes which follow have been placed under separate headings:

1. Madreporarian Reefs (outer Barrier type of reef).
2. Alcyonarian Reefs (Mainland type of reef).
3. (a) Rocky shores, southern side of the island.
   (b) Rocky shores, northern side of the island.
   (c) Rocky shores, western side of the island.
4. (a) Sand flats, southern side of the island.
   (b) Sand beaches, northern side of the island.

1. MADREPORARIAN REEFS

On the south western or weather side of the island a vigorously growing madreporarian reef forms a huge horse-shoe of coral, lying in an east-westerly direction the opening to the shallow enclosed lagoon being at the western end; on the shoreward side the reef impinges upon the dead exposed reef flat. The floor of the lagoon is composed of fine mud inhabited by what appear to be burrowing worms which form craters on the surface of the mud. In some areas there is a sparse growth of Thalassia and occasionally one sees commercial beche-der-mer, Curry and Tiger fish.

The landward side of the coral horse-shoe is composed of extensive masses of *Seriatopora, Stylophora, Acropora* and occasional *Fungia*. The upper surface of the reef has been killed and covered with algae and the alcyonarian coral *Xenia*. The *Seriatopora* is particularly well developed and acts as host for the crabs *Trapezia cymodoce* (Herbst), *Tetralia glaberrima* (Herbst) and *Galathea* sp., as well as several species of *Alpheus, Gonodactylus chiragra,* Ophiuroids and worms.

Large cup sponges occur amongst the corals below low water. The outer horn of the horse-shoe is composed of *Acropora,* especially staghorn forms and a few meandrines. The whole upper surface is exposed at low springs and is covered with algae and soft coral, *Xenia,* with a few massive alcyonaria such as *Sarcophyton*. Black Sea Urchins, *Diadema setosum,* occur in large numbers though the tests are hidden amongst the corals, only the dangerously sharp spines being allowed to protrude. The ocean side of the reef is composed almost entirely of *Acropora hebes*. A few specimens of the boring clam *Tridacna crocea* inhabit the dead surfaces of the reef.

2. ALCYONARIAN REEFS

The rampart or ridge which extends in an irregular line parallel to the foreshore on the north western side of the island and about 100 yards from high tide, rises about two or three feet above the level of the surrounding sandy area; the sea floor on the seaward side of the ridge slopes gradually so that one can wade along on the mud. The substratum upon which the corals grow appears to be dead coralla of previously thriving madrepores. Several breaks or channels occur in the line of reefs giving ready access to intertidal Thalassia and sand flat zones. Not only do the massive sarcophytons inhabit this area but also dome-shaped meandrines belonging to the following genera . . . *Euphyllia, Lobophyllia, Tridacophyllia, Symphyllia* with occasional masses of *Porites,* small growths of *Stylophora, Seriatopora* and one or two *Acropora* also occur. For some months during 1934 I kept a small crab-trap set on the outer edge of this reef and captured many specimens of two species of Swimming Crabs, *Thalamita,* which otherwise always managed to elude me. The mollusca of this reef were not especially numerous, small specimens of black-lipped pearl shell being the commonest. The only specimen of the Sacred Cowrie, *Ovula ovum* was obtained from this reef before my arrival at the Island. The small white cowrie, *Calpurnus verrucosus,* occurs as a commensal on the outside of *Sarcophyton* sp. The crabs found under the ridge were mostly swimming forms though occasional Oxyrhyncha were taken.

3. (a) ROCKY SHORES ON THE SOUTHERN SIDE OF THE ISLAND.

The rocky shores on the southern side of the island slope gradually from the steep hillside to the narrow mud-flat region and cover the upper tidal area from high water to about neap low. In some regions the stones are small and smooth, tending to form shingle beaches, in other parts there is an admixture of coarse sand and the stones are irregular in shape. The first crab we observe as we work from high tide level is *Epixanthus frontalis* H. M. Edward hiding under stones on sand at high water. A few feet further down the brightly coloured and swift moving Grapsoid, *Metopograpsus frontalis* Miers (formerly known as *M. messor*), occurs. Half way down the region one finds *Leptodius exaratus* hidden under stones and this crab reaches its greatest numbers in the lower half of the region. At the extreme edge of the region *Leptodius australis* Ward, and *Etisodes australis* Ward, take the place of *Leptodius exaratus* H. M. Edwards.

3 (b) ROCKY SHORES ON THE NORTHERN SIDE OF THE ISLAND.

The point of rocks wherein the coral pools are found slope precipitously into the sea and the intertidal region on this natural sea wall is in many parts vertical. A belt of barnacles and oysters extends from high water mark down to within a foot or two of low tide level where it is met by a thick growth of Sargassum weed. Only one species of oyster appears to be present, *Ostrea mordax*, and one associated barnacle is *Tetraclita squamosa*. About half way down the area the encrustation of oysters is about six or eight inches thick, intricate passages are formed under the oysters and with the aid of a crowbar masses of the oysters may be removed, they form ideal hiding places for a most extraordinary fauna.

Next to the oysters in importance is a large species of barnacle, *Tetraclita squamosa*, which does not always extend to the upper limits of the area. The small flat barnacle, *Chthamalus* sp. extends from the spray region just above high tide to approximately half down the area. High upon the rocks it occurs in the open but lower down it is on the under side of the oyster crannies. Two other species of barnacle occur at the lower extremity of the area, *Balanus imperator* and *Tetraclita vitiata*. There is also a species of *Ibla*.

The free living mollusca include *Nodilittorina* above high water mark. *Planaxis* are common at the top of the oyster zone. A species of *Nerita* with very strong ribs is found throughout the upper part of the zone, both in the open and in the crannies amongst the oysters. *Morula marginalba*, the oyster borer, occurs in the open and in the crannies amongst the oysters. *Montfortula*, the semi-slit limpet, hides under the masses of oysters in company with the common cowrie, *Erronea errones* and *Cronia pseudamygdala*. The largest loricates inhabit an area of exposed rock at the top of the region.

One of the interesting molluscan finds made in this area was *Synaptocochlea ornata* (Brazier) in crevices amongst the oysters and Mr. Tom Iredale kindly informs me that this is the first record of its habitat, proving its relationship with *Fossarina* and distinction from *Stomatella*.

Of the clinging mollusca, apart from the oysters themselves, young pearl oysters are not uncommon and a white malformed shell, *Isognomon*, in the crannies a little above the middle of the zone. These are soon joined by small Ark shells and a very hirsute small mussel, *Trichomya hirsuta*; towards the lower end of the zone these mussels become much larger, about one inch long.

The boring mollusca include two very distinct date mussels, one large and black the other small and white. These are found in the solid mass of lime deposited on the rock by the oysters. The date mussels are assisted in their destructive work by numerous Gephyrean worms. Polychaete worms are fairly numerous though they do not achieve any considerable size.

The Crabs associated with the oysters.

Metopograpsus frontalis moves freely about over the whole region and is very fleet. Towards the lower extremity of the zone *Actaea scabra* (Fabr.) occurs quite commonly in the labyrinthine passages under the oysters. It is a slow moving crab, creamy white in colour when young, dark reddish brown when adult; intermediate specimens show that the dark coloration appears as spots which become larger as growth proceeds until the final colour is achieved. One specimen was secured in the act of feeding upon the girdle of a large loricate.

Eurupellia granulosa A. M. Edw. This is perhaps the most important discovery in this region. Like *Actaea scabra* this species was previously known from few specimens and, in my experience on the Australian coast and elsewhere in the Pacific, both species had not been observed in our area. However, a native in Papua obtained a specimen of *Eurupellia granulosa* and a visitor at Lindeman Island sent me an *Actaea scabra* from a nearby island. Both species occur commonly in the oyster region where I obtained thirty-six specimens of *Eurupellia granulosa* and thirty-one of *Actaea scabra* in one day. The localization of species to a circumscribed area explains their scarcity in collections. Two other species occur in this region but owing to their being new to science I omit them from these notes.

3 (c). ROCKY SHORES ON THE WESTERN SIDE OF THE ISLAND.

Oysters do not develop to the extent that they do on the northern rocks. The outstanding region on the western shore is a narrow belt of large rocks uncovered at extremely low tides. The substratum is coarse sand and the crabs inhabiting this area are few in number and all are typical mainland species. *Charybdis spinifera* Miers, *Leptodius crassimanus* A. M. Edw., *Etisodes australis* Ward and the gonoplacid *Cryptoleutea lindemanensis* Ward. The latter is found in burrows it excavates under stones lying on muddy gravel. Near high tide level small colonies of *Uca tetragona* (Herbst) occur. The crabs dig burrows amongst the stones. This is a most unusual habitat for a *Uca* as most species are denizens of mangroves and mud flats.

4 (a). SAND FLATS ON THE SOUTHERN SIDE OF THE ISLAND.

This region is a narrow patch of sand which extends parallel to the shore between the intertidal rocky region and the dead coral reef. Occasional blocks of dead coral with large anemones, *Stoicactis* sp. and various alcyonarian corals attached occur throughout the area.

During the two years that I resided on the island I had ample opportunity to study the life of this region at night as well as in the daylight. I found that, unlike in the dead coral region, daylight made little difference to the species which habitually lived below the surface of the sand. They came to the surface in search of water rather than remained hidden from the possible attacks of sea birds. As the sand became bare and dry the small carnivorous snails, *Natica* and Nassa (*Nassarius* sp.) came out and commenced their search for food. The Naticoids pursued their prey, small bivales, which they disturbed as they moved swiftly over the surface of the sand. The little bivalve would pop out of the sand and fling itself along with the aid of its long narrow foot and the naticoid followed it smoothly, relentlessly. The anterior part of the Naticoid's body is capable of being suddenly cast forward with an action reminiscent of the Torres Strait islander casting his net and whenever it touched the foot of the prey it would raise the flap and cast it in an endeavour to cover the desired shell. As soon as it successfully engulfed the shell the Naticoid drew its whole foot up into a lump beneath its own shell entirely covering that of its victim. After pausing for several seconds the Naticoid would start off again in its travels over the sand and as it passed over its victim it attached the apparently paralysed bivalve to the dorsal surface of its tail and thus carried it along. I often observed this capture and

usually found that the Naticoid travelled only a short distance from the spot where the capture took place when it would commence to bury both itself and its prey beneath the sand. The Nassas have a different method of obtaining their food which consists of disabled marine animals or carrion. Usually the Nassa has to dispute the feast with a small white hermit crab, *Diogenes* sp. and several times I found disabled bailer shells covered with feeding Nassas and hermit crabs. The actual feeding process can be best observed when the Nassa directs its long siphon back over its shell, presses its mouth parts against the body of its prey and gradually everts a thick siphon-like tube (the proboscis) the aperture of which opens and closes with a rhythmic action as it absorbs the soft, jelly-like substance of the bailer. As the feeding progresses the tube elongates and is thrust in different directions within the body of its prey.

The crabs of the zone have to be sought by digging, though at times individuals are found on the dried surface, especially during the mid-winter springs which occur at mid-day exposing the sand to the sun for a long time causing not only crabs to rise to the surface but also heart and biscuit urchins, mollusca and a slender fish. I used a small seive through which I passed the surface layers of the sand, selecting areas where depressions had caught and held an inch or two of water. I used to work over the same areas each succeeding tide and invariably obtained specimens of the interesting crabs. Most of these species belong to the Leucosiidae or Pebble Crabs and are highly specialised for long periods of burial beneath the surface of the sand. As there was such a rich fauna of these crabs I became interested in studying the possibility of crossing the closely associated genera. All crabs breed by internal fertilization of the ova. Copulation is performed with the aid of paired organs called pleopods in the male, which are inserted into complemental apertures in the under surface of the female. In both sexes these sexual organs are covered by the closely adpressed abdomen or tail. It is to be observed in the Leucosiidae that immature individuals of both sexes have the abdomen rigidly adpressed against the body so that copulation is impossible until mature size is achieved. I have found that where two genera occur together in the same zone the mature individuals are so different in size that copulation, except with the members of their own genus, is impossible. This fact combined with extraordinary shapes assumed by the masculine pleopods, which in the Leucosiidae reach their highest development, forms the best criteria for the classification of the group.

Another family of crabs, Parthenopidae, is represented in this sand area, these also bury themselves in the sand and have developed two distinct methods of overcoming the difficulty of respiration while buried. Both species have extremely long nippers which can be applied against the respiratory apertures on the carapace. *Aulacolambrus* sp. inhabits areas of fine silt and its nippers form two minute tubes lined with bristles which sieve out the fine grains. *Rhinolambrus* sp. inhabits areas of coarse sand and consequently does not apply its nippers as closely as *Aulacolambrus*.

Five species of heart and biscuit urchins inhabit this area; the commonest are *Lovenia elongata* and *Maretia ovata*. Both are armed with two series of long slender spines, the longer of which are banded with yellow and red on *Lovenia elongata* and are very dangerous in both species. Just before the turn of the tide these urchins make their appearance on the exposed sand and display considerable speed as they endeavour to reach the water. *Metalia spatagus* and *Breynia australasiae* are rare inhabitants of the area. The two biscuit urchins, *Leganum depressum* and *Peronella lesueuri* occur at the edge of the spring lows, both bury themselves just below the surface of the sand, not as deeply as the heart urchins, nor are they harmful.

During the time I studied on the island I collected specimens of sand-dwelling sea-stars, *Astropecten granulatus*, *A. polyacanthus* and *A. vappa* on the southern side of the island but found them more numerous on the northern side.

4 (b). SAND BEACHES ON THE NORTHERN SIDE OF THE ISLAND.

The beach at the Boat Port is the most densely populated of all the beaches on the island. It is formed between two low headlands the bases of which are lined with oyster covered rocks. The high tide beach is steep and formed of coarse sand. At the western end a small mangrove creek extends back into the hills. The intertidal beach is formed of sandy mud, its surface generally undulating and with occasional deep craters dug by stingarees. At a level with the headlands the beach takes a sudden, almost imperceptible downward slope to the Thalassia zone.

Ocypoda ceratophthalma occupies its usual station at the high tide mark. The Sand Bubbler Crab *Scopimera inflata* is rare, only one or two specimens were observed at the base of the steep high tide beach. On the inshore surface of the intertidal beach there are small groups of Soldier crabs, *Mycteris longicarpus*. The most numerous crabs of the sand flat belong to the hermit crab family, a lively little *Diogenes*, white in colour and scuttling over the floors of shallow pools, frequently burying themselves entirely in the sand. The love life of these little crustaceans appears tempestuous for the male seizes the nipper of a female and drags her along the sand. Several large hermit crabs, *Clibanarius*, also patrol the pools. Where patches of Eel Grass, *Zostera*, occur the telescope-eyed crabs, *Macrophthalmus*, form colonies; each crab excavates a sloping burrow and lies out in front of the entrance in a specially formed trench. These little crabs feed upon the microscopic life left stranded by the falling tide. The most interesting crabs of this region belonged to the species *Myra australis* Haswell. Normally these crabs are collected in dredgings between the islands and the specimens taken between tides were all in varied stages of ecdysis, or shedding the body armour, and apparently had come up from their usual habitat for this purpose.

Coelenterates. The stinging anemone, *Actinodendron plumosum*, inhabits the beach from about half way across the intertidal beach. Each anemone is in a shallow crater which retains water during the low tide. I found that each was attached to the sunken piece of dead coral, usually about eighteen inches below the surface of the sand. Only once did I find any other organism in the water with the anemone; my attention was drawn to a biscuit urchin, *Peronella lesueuri*, lying against the anemone. When I seized it and commenced to pull I found that it was being held in place by a masked crab, *Dorippe* sp. This crab has the habit of carrying a foreign object over its back with its specially modified walking legs and I subsequently found several specimens on the beaches usually in shallow pools; each crab carried a piece of rotten wood.

In some areas of the beach *Cerianthus*, a worm-like anemone which encases its body in a thick silky tube, occurred; the expanded tentacles are long, cylindrical and tapering. During the low tide the anemone retires down its tube which stands a few inches above the surface of the sand. I did not observe any specimens of *Phoronis* associated with *Cerianthus* on the Lindeman beaches.

From time to time I collected sea pens, Pennatulacea, at the edge of the exposed flats. None, however, was used as hosts by the interesting Porcellanid crab, *Porcellanella*, that I found so common on similar sea pens at Cape York. The rarest sea pen on Lindeman Island is a large brown *Cavernularia* which stands about six inches above the level of the sand, the exposed portion looks like a brown sausage covered with pores from which the anemone-like polyps expand.

Notes on reefs in Kennedy Sound not on Lindeman Island.

SEAFORTH ISLAND.

At the north eastern end of Seaforth Island a vigorous fringing coral reef is developed. The intertidal flat is strewn with dead coral blocks on sand with dense growth of large algae such as Sargassum. The outer edge of the reef supports large series of Madreporaria as well as Alcyonaria and the steeply

sloping bank of talus outside the reef comes to within two fathoms of the surface at low tide. It was on this reef that many specimens of corals were collected. The interesting crab from this region is *Manella brevimana* Ward, which occurs commonly on the under surface of dead corals at the outer edge of the reef. During the winter months many specimens of the gastropod *Turbo petholatus* are collected but the species disappears during the summer months, cowries also abound.

Interesting Echinoderms were collected during my stay in the region. I found several specimens of the beautiful yellow sea star, *Iconaster longimanus,* commonly taken in the dredge in deep water, creeping up from the sloping talus bank onto the top of the reef. The large sea star, *Pentaceraster australis,* was observed feeding upon a soft coral, *Sarcophyton.*

Three specimens of the curious soft sea urchin, *Asthenosoma* sp., were collected in shallow pools. In life these urchins are very flattened, the aboral surface rises to a low rounded dome, two series of spines occur which can be moved at an extraordinary speed, the finer spines are very sharp and inflict very painful wounds, so much so that after the first experience specimens were collected with the aid of sticks or the crowbar. The Port Jackson Slate-pencil Urchin, two specimens of *Phyllacanthus parvispinus,* were collected characteristically wedged into crannies amongst dead corals, the species appears to be rare in the Lindeman region.

SEA STAR REEF, Shaw Island.

This extensive fringing reef extends almost from Burning Point to Echo Bay, it is very wide and two large sand banks are formed upon it. The greater part of the intertidal surface is covered in sand and fine mud with masses of dead and living corals becoming more and more numerous towards the outer edge.

The outstanding animal is the big and brightly coloured sea star, *Protoreaster nodosus;* individuals lie without attempt at concealment, often in large numbers and during the midwinter spring lows they are exposed to the air. Occasional specimens of *Pentaceraster australis* occur also. The small plum-coloured *Echinaster luzonicus* lies exposed amongst the algae-covered dead corals and a small Polynoid worm, coloured like the star, is found creeping over the under surface of its arms.

The fauna of the sand-banks is intensively interesting and may be studied towards the end of the period of exposure for it will then be found that the inhabitants come to the surface in search of moisture. A minute olive shell occurs and is detected by the slit it cuts through the surface of the sand. Several large strombs and occasional spider shells, *Pteroceras,* occur. A small Xanthid crab, *Mertonia* sp., comes to the surface and several pebble crabs, Leucosiidae, make their appearance. The interesting crab of this reef is *Charybdis natator* which occurs in shallow water where it excavates a compartment under a mass of living or dead coral. The crab is large and dark red in colour and has a wide range of distribution, individuals are frequently seen swimming at the surface of the sea south of Shaw Island as though migrating from one locality to another. Another crab collected at Sea Star Reef is a small sand-dwelling species *Kraussia* sp. which I had only collected previously on the Australian coast at the Capricorn Group, Queensland.

The interesting solitary coral, *Cycloseris cycloites,* occurs upon the sand between tides, I had not seen this species on any other reefs in the Lindeman region. A single specimen of *Acrozoanthus australiae* was collected at the northern end of the reef where it was found standing in the sand in shallow water; dead fragments of this Zoantharian were previously collected in the dredge in deep water. Saville Kent noted the occurrence of this strange creature in Queensland waters and gave notes upon the association of the polychete worm which lives in the tube upon which individual *Acrozoanthus* take up their abode.

A COMPARISON OF THE CAPRICORN GROUP AND LINDEMAN ISLAND

In previous papers (Ward, 1928, *Austr. Zool.*, 5 (3): 241-246, pls. 27-29 and 1932, *ibid.*, 7 (3): 237-255) I described the ecological zones of a coral cay in the Capricorn Group which lies at the southern end of the Barrier Reefs. The outstanding difference between the two localities lies in the fact that in the Capricorn Group the islands stand upon great pedestals of coral, the edges of which fall away sheer to the sea floor forming precipitous walls so that bottom-living organisms such as crabs, shells and echinoderms cannot creep up into the intertidal regions. Thus we find two well defined faunas, one dwelling upon the top of the reefs, the second on the sea floor surrounding the reefs.

At Lindeman Island the shores slope gradually to the deep water and even where madreporarian reefs are formed these tend to slope down gradually rather than end abruptly. Another important factor is the amount of fresh water which is caught by the high rocky island during the rainy season. The inshore waters at Lindeman become brown with detritus carried down from the hills. This does not occur at the Capricorn Group.

As I have shown in this paper the foreshores of Lindeman Island offer greater variety of habitat for the development of specialised faunulae than the islands and reefs of the Capricorn Group. It is interesting to observe that I have collected two hundred and fifty species of crabs at Lindeman Island and one hundred and thirty at the Capricorn Group and of these less than forty were found in both localities. The forms confined to the intertidal zones in both localities were the most unlike, while those inhabiting the deeper waters outside the reefs were more similar. Even in the depths where exploration was only possible with the dredge and otter trawl, considerable difference was found in the types of zones in the two localities.

Around Lindeman the depths range down to 30 fathoms. The sea floor varies from rock to mud and we found a different fauna in each zone. In the narrow channels between Lindeman and Shaw Island the tides sweep very strongly, making the use of the dredge very difficult, but during the slack of the tide we managed quite a few hauls in depths up to thirty fathoms. The alcyonarian corals grow thickly in this depth and they are attended by many crabs, sea-stars, and holothurians. The mud zones down to ten fathoms support a remarkable fauna which changes its character at night; during the day the trawl brought up fish with few specimens of holothuria and crabs, but at night the crabs became the predominant forms.

Unfortunately dredging was not indulged in to any great extent at the Capricorn Group, but even the little that was done, showed that the sea floor fauna was not as varied as that at Lindeman Island.

A Note on Overwintering in **Danaus Plexippus** (Linnaeus) (Lepidoptera, Nymphalidae) in Australia

By C. N. SMITHERS

The Australian Museum, College St., Sydney.

The occurrence of overwintering clusters of *Danaus plexippus* (L.) (the Wanderer or Monarch butterfly) has recently been reported from New Zealand (Ramsay, 1964).

Observations have been made in Australia on this species and a marking and release programme has been in operation since the latter part of 1962. So far, overwinter clustering sites (the first recorded in Australia) are known in the Razorback area and near Theresa Park in New South Wales. The Razorback site was discovered by Mr. D. Aitkin in 1962 and reported to the author in 1963. At Theresa Park, in 1962, Mr. G. Seymour found large numbers of wings on the ground under trees in a narrow gulley although clustering butterflies were not present at the time. Subsequently, in April, 1963, a unidirectional flight of *D. plexippus* was observed at Menangle Park and an extension of the line of flight on a map passed through the site at which the wings had been found. On investigation, clusters were found to be present there. A third site is known to exist near Otford but the "entomologist" to whom it is known has refused to disclose its exact location.

In addition to the above sites, clusters have been reported from Dungog, Menangle Park, Casula, Muswellbrook and the upper Wollondilly River valley (the last dating from the 1930's) .Whether these are overwintering sites or areas in which temporary clusters are formed is not known. Also, there are several districts in and near the Sydney area in which *D. plexippus* occurs throughout the winter but in which the clustering habit has not, as yet, been observed.

In April, 1962, both the Razorback and Theresa Park sites appear to have carried heavy populations although neither counts nor estimates of numbers were made.

In 1963, the Theresa Park site contained an estimated 40,000 specimens on 3rd May; by the 10th May the population had dropped to about 19,000. By the end of June the clusters had completely disappeared. The Razorback site had an estimated 15,000 specimens on 30th June (when the site was first visited) but the numbers fell rapidly during July and by the 27th July the butterflies had dispersed (obs. M. Upton). At both sites mortality was high as evidenced by the numbers of wings to be found on the ground. These, however, appear to have been less than in 1962 suggesting that the 1962 clusters were made up of a greater number of individuals.

In 1964, clusters did not form at all at Theresa Park; at Razorback clustering had started by 2nd April with about 100 specimens, numbers rose to about 500 during April and all had left the site by the end of May.

In 1965, up to the time of writing (9th July, 1965) there has not been any sign of clusters at either site. It seems, therefore, that numbers at the overwintering clustering sites have fallen steadily over the last three winters.

The full data and results of the present studies will be published in due course but it can be said now that some aspects of the pattern of behaviour of this species do not correspond with that of the same species in North America, as indicated by Urquhart (1960), at least in the areas of Australia in which most of the investigations have been made. The pattern may, perhaps, correspond more closely in other parts of Australia, e.g. Victoria or southern New South Wales. Strong tendencies to migrate have not yet been detected; only one confirmed report of obvious unidirectional flight is available; all known clustering sites, whether overwintering or not, are adjacent to areas with good summer growth of the host plant (*Asclepias* sp.); breeding can continue well

into winter in protected situations (e.g. Spencer, Bay View, Booker Bay area) even though it may have ceased several weeks earlier in colder areas only a few miles distant.

Further work will confirm or contradict these preliminary notes and it is hoped that more intensive marking and release work over a wider area will give more information on movement. The author will gladly provide labels and marking instructions to anyone interested in marking and releasing this and other migratory species.

REFERENCES

Ramsay, G. W. 1964—Overwintering swarms of the Monarch Butterfly (*Danaus plexippus* [L]in New Zealand. *N.Z. Entomologist* 3 (3): 10-16, 1 fig.

Urquhart, F. A. 1960—*The Monarch Butterfly*. Toronto, xxiv, 361 pp.

Caecilius soehardjani, a new name for **Caecilius ferrugineus** Soehardjan and Hamann. (Psocoptera: Caeciliidae)

By C. N. Smithers,
Australian Museum, Sydney.

During work on the preparation of a list of described species of Psocoptera it has become evident that the name *Caecilius ferrugineus* has been used twice. Badonnel (1945, p. 36, figs. 9-14) used this name for a species of psocid from Morocco and the same name was used by Soehardjan and Hamann (1959, p. 7, figs. 25, 26) when describing a species from Bogor. The latter species requires renaming and for *Caecilius ferrugineus* Soehardjan and Hamann (not *Caecilius ferrugineus* Badonnel) I propose the name *Caecilius soehardjani* nom. nov.

References

Badonnel, A. 1945. Contribution à l'étude des Psocoptères du Maroc. Voyage de L. Berland et M. Vachon. *Rev. franc. Ent.* 12: 31-50, 48 figs.

Soehardjan, M. and Hamann, H.H.F., 1959. Second contribution to the Indonesian Psocidfauna; notes on some recent collectings. *Idea* 12: 1-13, 35 figs.

A BIBLIOGRAPHY OF THE PSOCOPTERA (INSECTA)

By C. N. Smithers

Australian Museum, Sydney.

The insect order PSOCOPTERA has, in general, been somewhat neglected. Many factors have contributed to this neglect. It is usually referred to as a "small" or "minor" order; the insects themselves are small and frequently at least some dissection is necessary before they can be adequately studied; they have seldom been reported as being of economic significance and so have not received the attention given to groups which include pest species; the order has not been monographed in recent years and there are few modern works dealing with the faunas of particular regions; finally, the literature on the order is very scattered, relevant papers sometimes appearing in infrequently encountered journals. It is thus not an easy task for a student to obtain the background information necessary in order to make a contribution to knowledge of the group.

This bibliography is an attempt to assist psocidologists to find the significant papers without having to make extensive search. It is too much to hope that the list of references which follows is complete or that it is free from errors; no bibliography could be so. This work is not an attempt to attain perfection where this is impossible; it is an attempt to provide a working tool which will relieve students of the Psocoptera of the drudgery of compiling their own bibliographies. It is, however, believed that no major paper has been omitted and every attempt has been made to reduce errors to a minimum. The author will be happy to hear of errors and omissions.

The need for a bibliography was stressed by Dr. K. Sommerman in 1960. By this time a substantial card index to Psocid literature had been compiled for my own use and it was decided to use this as a basis for a full bibliography. In order to achieve this, lists of references were prepared and circulated to as many psocidologists as could be found who were willing to peruse them. Corrections and additions were sent by these co-operators for inclusion in the master card index. In this way it was possible to obtain access to the literature records of most active psocidologists. When the circulating lists were returned as many of the references as possible were checked against originals, reprints, photostats etc. in private and institutional libraries in Australia, America and Great Britain. At the same time every effort was made to seek out additional references which had been overlooked. The results of this work and co-operation are presented below as a bibliography.

The entries in the bibliography are arranged alphabetically under authors' surnames and in chronological order of years for each author. In most cases the abbreviations given are those of the "World List." In many cases where the title of the paper does not give any indication of its contents a brief note is given to indicate this.

Works coming to notice until September 30th, 1964 have been included. It is hoped that it will be possible to keep this bibliography up to date and to publish supplementary information from time to time. To this end authors of papers in which reference is made to the Psocoptera are asked to send a copy of their paper to the author and to ensure that their paper receives mention in the Zoological Record by sending a copy to the editor of that journal.

Two entries are of special value from the bibliographical point of view. Sala, I. (1928) contains a list of papers published by L. Navás up to 1927; Carpenter, F. M. and Darlington, P. J. (1954) contains a bibliography of papers by N. Banks.

It has been pointed out that this bibliography is the result of co-operation amongst present-day psocidologists. Mere acknowledgment of this co-operation hardly gives an indication of its extent nor does justice to the generous way in which it was given. I would like to record my sincere thanks to the following for their assistance in providing additions and correcting errors. Dr. A. Badonnel, Dr. E. Becker-Migdisova, Dr. E. Broadhead, Dr. F. M. Carpenter, Dr. P. J. Chapman, Dr. M. Clarke, Dr. L. Danks, Dr. A. Gurney, Mr. D. Kimmins, Dr. O. Martynova, Dr. L. Mockford, Dr. E. Mumford, Mr. A. M. Nadler, Dr. S. Obr, Mr. J. V. Pearman, Dr. K. M. Sommerman, Dr. S. Tada, Dr. I. Thornton, Dr. C. Tsutsumi, Dr. V. Vishniakova, Dr. A. Wapshere and Dr. J. Wlodarczyk. Dr. Gurney also kindly provided notes on the contents of some of the papers. I would also like to thank the librarians of the Australian Museum, the General, Zoology and Entomology libraries of the British Museum of Natural History and the librarian of the Royal Entomological Society of London for assistance in seeking out some of the more difficult-to-find references. Much of the final checking was carried out in institutional libraries during a world trip, undertaken primarily for other purposes, and I would like to thank the Science and Industry Endowment Fund, Rockefeller Foundation, Society of the Sigma-Xi and the British Council for financial assistance covering various parts of the trip.

Without the assistance of all these individuals and institutions this bibliography could not have been prepared.

Aaron, S. F.

1883. Description of new Psocidae in the collection of the American Entomological Society. *Trans. Amer. ent. Soc.* 11: 37-40, pl. ix.
1884. Collecting on the Gulf Coast of Southern Texas. *Papilio* 4: 159-161.
1886. On some new Psocidae. *Proc. Acad. nat. Sci. Philad.* 38: 13-18, pl. 1. American spp.
1933. (Untitled notes in popular style). *Nature Mag.* 22: 34, 1 fig.

Acloque, A.

1897. *Faune de France. Orthoptères, Neuroptères, Hyménoptères, Lepidoptères, Hemiptères, Diptères, Aphaniptères, Thysanoptères, Rhipiptères.* Paris. i-viii, 516 pp., 219 figs. (Psocidae: pp. 17-19, fig. 7).

Albarda, H.

1889a. Catalogue raisonné et synonymique des Nevroptères, observés dans les Pays-Bas et les Pays limitrophes. *Tijdschr. Ent.* 32: 211-376. (Psocoptera: pp. 227-241). Lists 39 spp. with synonyms and remarks.
1889b. Notes on *Psocus obscurus* Rambur. *Ent. mon. Mag.* 25: 210. Compares *Peripsocus phaeopterus* Steph. with *P. obscurus* Ramb.

Alkan, B.

1961. *Troctes entomophilus* End. a species of insect new to Turkey found in grain silos at Trebizond. *Koreima* 2 (8): 4-5.

Allen, B.

1698. An account of a Gall-Bee and the *Scarabaeus galeatus pulsator* or the Death Watch. *Phil. Trans.* 20 (245): 375-378.

Allen, R. W.

1959. Preliminary note on the larval development of the Fringed Tapeworm of sheep, *Thysanosoma actinioides* Diesing 1834, in Psocids (Psocoptera, Corrodentia). *J. Parasit.* 45: 537-538, 1 fig. *Liposcelis bostrychophilus* and *Rhyopsocus* sp. as hosts.
1960. Method of culturing psocids for use in parasitological investigations. *J. Parasit.* 46: 20. Species cultured not mentioned.

Altherr, E.

1939. Le fauna des mines de Box, avec étude speciale des Nématodes. *Rev. suisse zool.* 45 (21): 567-720.

Anonymous

1886. Catalogue of the Trichoptera, Neuroptera, Ephemeridae and Psocidae described as new in 1884. *Ent. Nachr.* 12: 188-191.

1937. Book-lice or Psocids (Psocidae). *Insect Pest Leafl. N.S.W.* 53, 2 pp., 1 fig. Control measures.

1940. Psocids, Book Lice, Dust Lice etc. *Brit. Mus. Nat. Hist. Econ. Leaflet* 4: 1-3, 1 fig.

Argarwal, R. A.

1956. Some mycophagous insects and their parasites associated with sugarcane. *Curr. Sci.* 25 (10): 332. *Troctes bostrychophilus.*

Arkhangel 'Skii, N. N.

1926. Some observations on various methods of controlling pests of stored products in Russia. *Bull. N. Caucas. Pt. Prot. Sta.* 1:100-119. Mentions *L. divinatorius* —cf. Blair, C.R., 1940.

Arndt, W.

1928. *Liposcelis corrodens* (Heym.) als Schädling an Griesmehlvorraten. *Mitt. Ges. Vorratsschutz* 4: 11-12.

1931. Die Copeognathen der arktischen Gebietes. *Fauna arct., Jena* 6: 59-60.

Ashmead, W. H.

1879. On a new *Psocus. Canad. Ent.* 11: 228-229.

1894. Notes on cotton insects found in Mississippi. *Insect Life* 7: 25-29, 240-247. (Psocidae: pp. 28-29). *Caecilius mobilis* mentioned, *Psocus gossypii* described.

Ausserer, C.

1869a. Neuroptera tirolensia. *Z. Ferdinand.* (3) 14: 219-288, pls. I, II. (Psocidae: esp. pp. 229, 232, 284, 288).

1869b. Neurotteri Tirolesi, cella diagnosi di tutti genera' europei. 1. Pseudoneurotteri. *Annu. Soc. nat. Modena* 4: 71-156, tab. 8-9. (Psocids: pp. 96-97, 102, 146-149, 155).

Back, E. A.

1920. Book-lice or Psocids, annoying household pests. *Fmrs'. Bull. U.S. Dep. Agric.* 1104, 4 pp. Mention of infestations, control.

1939a. Psocids in dwellings. *J. econ. Ent.* 32: 419-423. Records of occurrences in houses, control measures.

1939b. Psocids, annoying house pests. *Leafl. U.S. Dep. Agric.* 189, 4 pp. General remarks on infestation, control measures.

1939c. House insulation and insect infestations. *Proc. ent. Soc. Wash.* 41: 129-136.

1940. Book worms. *Smithsonian Report* 1939: 365-374, pls. 1-18. Psocid mentioned p. 371.

Back, E. A. and **Cotton,** R. T.

1922. Stored grain insects. *Fmrs' Bull. U.S. Dep. Agric.* 1260, 4 pp.

Badonnel, A.

1931a. Contribution a l'étude de la faune du Mozambique. Voyage de M.P. Lesne (1928-1929). 4e note. Copéognathes. *Ann. Sci. nat. Zool. ser.* 10, 14: 229-260, 37 figs. (This should be numbered "5e note" (see footnote in Badonnel 1932a.)).

1931b. Copéognathes de France (IIIe note). Liste de quelques espèces trouvées dans les Pyrénées-Orientales, et description d'un nouveau genre des environs de Banyuls-sur-Mer: *Nymphotroctes Denisi* sp.n. *Bull. Soc. zool. Fr.* 56: 341-347, 5 figs.

1931c. Première note sur les Copéognathes de France. *Bull. Soc. zool. Fr.* 56: 98-112, 13 figs.

1931d. Copéognathes de France (IIe note). Sur les pièces buccales de *Scoliopsyllopsis latreillei* Enderlein. *Bull. Soc. zool. Fr.* 56: 250-257. 5 figs. Family Scoliopsyllopsidae raised.

1932a. Contribution a l'étude de la faune du Mozambique — Voyage de M.P. Lesne (1928-1929). 7e note. Supplement aux Copéognathes. *Bull. Soc. zool. Fr.* 57: 105-117, 14 figs.

1932b. Sur les genitalia des Psoques (note préliminaire). *Bull. Soc. zool. Fr.* 57: 476-481.

1932c. Copéognathes de France (IVe note). I. Sur un nouveau genre de famille des Caeciliidae. II. Sur l'existence des gonapophyses chez les femelles du genre *Liposcelis* Motsch. 1852 (= Troctes Burm. 1839). *Bull. Soc. ent. Fr.* 37: 77-79, 5 figs.

1933a. Description de la ponte de *Psocus bipunctatus* L. *Bull. Soc. zool. Fr.* 58: 69-71.

1933b. Sur l'anatomie de *Stenopsocus stigmaticus* Imh. et Labr. (Note préliminaire). *Bull. Soc. ent. Fr.* 38: 39-44.

1934. Recherches sur l'anatomie des Psoques. *Bull. biol., Paris, Suppl.* 18, 241 pp., 80 figs. General account of internal and external anatomy.

1935a. Psocoptères de France. 5e note. Liste d'espèces nouvelles ou peu connues avec indication du quelques synonymies. *Bull. Soc. ent. Fr.* 40: 199-203.

1935b. Psocoptères de France. VIe note. Description d'un espèce nouvelle du genre *Neopsocus* Kolbe, suivie à une révision des espèces de ce genre. *Rev. franç. Ent.* 2: 47-51, 8 figs.

1935c. Observations sur la biologie de *Lachesilla pedicularia* L. var. *brevipennis* Enderlein (*L. limbatus* Enderlein 1924). *Bull. Soc. zool. Fr.* 60: 105-115, 5 figs.

1935d. Psocoptères nouveaux d'Afrique et d'Arabie. *Rev. franç. Ent.* 2: 76-82, 15 figs.

1935e. Mission scientifique de l'Omo — Psocoptères. *Mém. Mus. Hist. nat. Paris* 4: 155. One sp. mentioned.

1935f. Contribution à l'étude des Psocoptères à Madagascar. *Bull Acad. Malgache N.S.* 18: 97-120, 4 pls. Includes list of spp. known from Madagascar.

1935g. Notes sur les Psocoptères de la Cote d'Or. *Bull. Sci. Bourgogne* 5: 75-78. Lists species from the area.

1936a. Sur les gonapophyses des femelles du genre *Ectopsocus* (Psocopt.). *Livre jubil. Bouvier.* Paris. (Psocoptera: pp. 101-104, 3 figs.).

1936b. Psocoptères de France (VIIIe note). *Neopsocopsis,* nouveau genre de Psocidae à adulte ornés de poils glanduleux. *Bull. Soc. zool. Fr.* 60: 418-423, 8 figs.

1936c. Psocoptères de France (7e note). Espèces nouvelles ou peu connues et description de deux espèces inédites. *Bull. Soc. ent. Fr.* 41: 24-29, 6 figs.

1936d. Nouvelle espèce de Psocoptère d'Algérie. *Rev. franç. Ent.* 3: 96-100, 6 figs.

1936e. Les Caeciliides européens à ailes ocracées. *Rev. franç. Ent.* 3: 177-189, 20 figs.

1936f. Sur l'hypopharynx des Psoques. *Bull. Soc. zool. Fr.* 61: 14-18.

1938a. Psocoptères de France (9e note). Diagnoses préliminaires et nouvelles captures. *Bull. Soc. ent. Fr.* 43: 17-22.

1938b. Sur la biologie de *Psyllipsocus ramburi* Selys-Longchamps (Psocoptera). *Bull. Soc. ent. Fr.* 43: 153-158.

1938c. Sur la biologie de *Neopsocus rhenanus* Kolbe (Psocoptères). *Bull. Soc. zool. Fr.* 63: 106-110.
1938d. Sur le *Psocus hirticornis* Reuter 1893. *Bull. Soc. zool. Fr.* 63: 237-239.
1943a. Psocoptères du Cameroun (Mission P. Lepesme, R. Paulian et A. Villiers 1939). *Rev. Zool. Bot. afr.* 37: 134-156, 51 figs.
1943b. Psocoptères cavernicoles du Macédonie et Herzégovine. (Voyage de P. Remy, R. Hussen et A. Schweitzer). *Bull Soc. ent. Fr.* 48: 8-9.
1943c. Psocoptères. *Faune Fr.* 42: 1-164, 375 figs. External anatomy, biology, study methods, keys, descriptions, illustrations to spp. in France.
1944. Contribution a l'étude des Psocoptères de l'Atlantide.
I. Un genre nouveau atlantidien.
II. Psocoptères de Canaries.
III. Psocoptères de Madère.
IV. Psocoptères de Açores.
Rev. franç. Ent. 11: 47-60, 22 figs.
1945a. Dimorphisme alaire des femelles de *Neopsocus rhenanus* Kolbe. *Bull. Soc. zool. Fr.* 70: 131-135.
1945b. Contribution à l'étude des Psocoptères du Maroc. Voyage de L. Berland et M. Vachon. *Rev. franç. Ent.* 12: 31-50, 48 figs.
1946a. Les psoques des Iles atlantides. *Mém. Soc. Biogeogr.* 81: 239-243. Similar in content to Badonnel 1944.
1946b. Psocoptères du Congo Belge. *Rev. Zool. Bot. afr.* 39 (2): 137-196, 126 figs.
1947. Croisière du Bougainville aux îles australes françaises XIV. Psocoptères. *Mém. Mus. Hist. nat. Paris, N.S.* 20: 25-30, 15 figs.
1948a. Psocoptères de la Guinée française (Mission Lamotte 1942). *Rev. franç. Ent.* 15: 80-88, 14 figs.
1948b. Psocoptères du Congo Belge (2e note). *Rev. Zool. Bot. afr.* 40 (4): 266-322, 126 figs.
1948c. L'effet de groupe chez *Psyllipsocus ramburi* Selys Longchamps (Psocoptères) — note préliminaire. *Bull. Soc. zool. Fr.* 73: 80-83.
1949a. Psocoptères de la Cote d'Ivoire. Mission Paulian-Delamere (1945). *Rev. franç. Ent.* 16: 20-40, 61 figs.
1949b. Sur le déterminisme de l'effet de groupe chez *Psyllipsocus ramburi* Selys Longchamps (Psocoptera). *C.R. Soc. Biol. Paris* 228: 1517-1519.
1949c. Psocoptères du Congo Belge (3e note). *Bull. Inst. Sci. nat. Belg.* 25 (11): 1-64, 83 figs.
1951. *In* Grassé, P. "*Traité de Zoologie.*" Paris. 17 vols. (Psocoptera: Vol. 10, fasc. 2, pp. 1301-1340, figs. 1135-1170).
1952. Psocoptères, *in* Delamere-Deboutteville, C. et Paulian, R. Faune des Nids et des Terriers en Basse Cote d'Ivoire. *Encycl. Biogeogr. et Ecol.* 8: 3-116, illustr. (Psocoptera: pp. 78-80).
1955. Psocoptères de l'Angola. *Publ. cult. Cia. Diamant Angola* 26: 1-267, 625 figs.
1956. *In* Tuxen, S.L. *Taxonomist's Glossary of genitalia in Insects.* Copenhagen. 284 pp. 215 figs. (Psocoptera: Chapter 25, pp. 143-148, figs. 173-178). General account of genitalia.
1959a. Développement des ailes de *Psyllipsocus ramburi* Sel. — Long.: essai d'interpretation. *Bull. Soc. zool. Fr.* 84 (1): 91-98, 2 figs.
1959b. Un psoque cavernicole du Moyen-Congo. *Rev. suisse Zool.* 66 (33): 761-764, 8 figs.
1959c. Psocoptères. *Explor. Parc. nat. Albert, Mission G.F. de Witte (1933-1935).* Fasc. 95: 3-26, 39 figs. New genus and spp., new records, from Albert National Park.
1962a. Psocoptères. *Biologie de l'Amérique australe.* Paris. (Psocoptères Vol. 1, pp. 185-229, 104 figs).

1962b. Contribution à l'étude de la faune d'Afghanistan. 36. Psocoptères. *K. fysiogr. Sällsk. Lund Förh.* 32: 1-6, 6 figs. 3 spp. including a new *Prionoglaris.*

1963a. Psocoptères terricoles, lapidicoles et corticoles du Chili. *Biologie de l'Amérique australe.* Paris. (Psocoptera: Vol. 2, pp. 291-338, 88 figs.).

1963b. Sur les Psocoptères des Açores et de Madère. Report No. 31 from the Lund University Expedition in 1957 to the Azores and Madeira. *Bol. Mus. Funchal* 17 (63): 66-78, 19 figs.

1963c. Sur le genre *Lesneia* Badonnel (Psocoptera) avec description d'une nouvelle espèce. *Arch. Zool. exp. gén.* 102: 41-48, 15 figs.

Badonnel, A. and **Hamard,** G.

1959. Une espèce de Psocoptère nouvelle pour la France. *Cahiers nat.* (*n.s.*) 15:27.

Baeta Neves, C. M.

1952. Os Psocoptera da entomofauna florestal portuguesas. *Boll Soc. portug. Cienc. nat.* (2) 4: 9-11.

Bagnall, R. S.

1915. *Pterodela livida* Enderlein, a psocid new to the British fauna. *Ent. Rec.* 27: 228.

1926. Further records of *Hyperetes brittanicus* Harrison. *Ent. mon. Mag.* 62: 22. British records.

Bakker, H. A.

1943. Mierenleeuwen en een nieuwe Psocide. *Tijdschr. Ent.* 86: LXV-LXVI. (Psocid: p. LXVI). *Bertkauia lucifuga* mentioned.

Ball, A.

1920. (Report in minutes of meeting of 6th November, 1920). *Ann. Soc. ent. Belg.* 60: 178. 2 spp. recorded as new for Belgium.

1926a. Quelques notes concernant les Psoques belges. *Bull.* (*Ann.*) *Soc. ent. Belg.* 66: 256-264.

1926b. Les Psocidae de Belgique. *Bull.* (*Ann.*) *Soc. ent. Belg.* 66: 331-349, 3 pls.

1931. Note descriptive concernant un *Ectopsocus* des Etats-Unis (Psocoptera-Peripsocidae). *Mém. Soc. ent. Belg.* 23: 188-196, pl. vi, figs. 1-6.

1936. Un psoque qui perd une partie de ses pièces buccales en devenant adulte. *Mém. Mus. Hist. nat. Belg.* 2 ser., 3: 395-399, 9 figs.

1937. Contribution a l'étude des Psocoptères. I. Description de trois espèces nouvelles de *Mesopsocus* du Maroc. *Bull. Mus. Hist. nat. Belg.* 13 (42): 1-11, figs. a-d, 5 pls.

1940. Contribution a l'étude des Psocoptères. II. Description d'une espèce nouvelle de *Liposcelis* de l'île de Chypre et du Liban. *Bull. Mus. Hist. nat. Belg.* 16 (20): 1-3, 2 figs., 1 pl.

1943. Contribution a l'étude des Psocoptères. III. *Ectopsocus* du Congo belge, avec une remarque sur le rapport IO/D. *Bull. Mus. Hist. nat. Belg.* 19 (38): 1-28, 22 figs.

Banks, N.

1892. North American Neuroptera. *Trans. Amer. ent. Soc.* 19: 327-373 (Psocids: pp. 327-331, 343-345, 372).

1893. Two uncommon insects. *Ent. News* 4: 268. Records *Amphientomum hageni* Pack. from Long Is., New York.

1897. *In* Call, R. E. Some notes on the flora and fauna of Mammoth Cave, Ky. *Amer. Nat.* 31: 377-392. (Psocidae: p. 382, pl. x, fig. 4). *Dorypteryx (?) hageni.*

1899. The Psocidae of an old snake-fence. *Ent. News* 10: 260-261.

1900a. A new genus of Atropidae (*Psocinella* n.g.) *Ent. News* 11 (4): 431-432, figs. (unnumbered) on page 431. *Psocinella slossonae* from Florida.

1900b. Two new species of *Troctes*. *Ent. News* 11: 559-560.

1900c. Psocids at light. *Ent. News* 11: 601. *Psocus virginianus, purus, sparsus, pedicularia* mentioned. No localities given, merely noted as taken at light.

1900d. New genera and species of Nearctic Neuropteroid Insects. *Trans. Amer. ent. Soc.* 26: 239-259.

1901. A list of Neuropteroid insects from Mexico. *Trans. Amer. ent. Soc.* 27: 362.

1903a. Some new Neuropteroid Insects. *J.N.Y. ent. Soc.* 11: 236-243.

1903b. (Untitled note under heading "Notes and News"). *Ent. News* 14: 241. *Troctes needhami* End. = *T. niger* Banks; *T. bicolor* End. = *T. bicolor* Banks. All from Virginia.

1903c. Neuropteroid insects from Arizona. *Proc. ent. Soc. Wash.* 5: 237-245, pl. IV. (Psocidae: p. 237, pl. iv, fig. 1). 2 spp. mentioned, *Psocus conspersus* described.

1904a. A list of Neuropteroid insects, exclusive of Odonata, from the vicinity of Washington. *Proc. ent. Soc. Wash.* 6: 201-217, pl. II. (Psocidae: pp. 202-204, pl. ii, figs. 3, 10, 18). 31 spp. listed, 2 described as new.

1904b. Neuropteroid insects from New Mexico. *Trans. Amer. ent. Soc.* 30: 97-110, pl. i.

1905a. List of Neuropteroids. *Invert. Pacifica* 1: 85-91. (Psocids: pp. 87-88).

1905b. Descriptions of new Nearctic Neuropteroid insects. *Trans. Amer. ent. Soc.* 32: 1-20, pls. i, ii. (Psocids: pp. 1-3).

1907a. New Trichoptera and Psocidae. *J.N.Y. ent. Soc.* 15: 162-166, figs. 1-5.

1907b. A list of Neuropteroid insects from North Carolina. *Proc. ent. Soc. Wash.* 9 (1-4): 149-156. (Psocids: pp. 149-150). 9 spp. listed.

1907c. Catalogue of the neuropteroid insects (except Odonata) of the United States. *Amer. Ent. Soc.*, Philadelphia (separate publication). 53 pp. (Psocids: pp. 6-10).

1908. Neuropteroid Insects — notes and descriptions. *Trans. Amer. ent. Soc.* 34: 255-267, pls. XVII-XIX. (Psocidae: pp. 257-258).

1913a. Synopses and descriptions of exotic Neuroptera. *Trans. Amer. ent. Soc.* 39: 201-242, pls. xxiii-xxvi. (Psocid: p. 205).

1913b. The Stanford Expedition to Brazil, 1911. Neuropteroid Insects from Brazil. *Psyche, Camb. Mass.* 20: 83-89, pl. 4. (Psocidae: pp. 83-84, pl. 4, figs. 2, 14.)

1913c. On a collection of neuropteroid insects from the Philippine Islands. *Proc. ent. Soc. Wash.* 15: 170-180, pls. viii-ix. (Psocids: p. 171, no figs.). 4 spp. mentioned, 2 spp. described as new.

1914. Zoological Results of the Abor Expedition, 1911-1912. XXVI. Neuropteroid Insects. *Rec. Indian Mus.* 8: 351-356, pl. XXV. (Psocidae: pp. 351-353, pl. XXV, figs. 1, 3, 5, 7).

1915. New neuropteroid insects, native and exotic. *Proc. Acad. nat. Sci. Philad.* 66 (3): 608-632, pl. 28. (Psocidae: pp. 611-612, pl. 28, figs. 15, 16). North American spp. only.

1916. Neuropteroid insects of the Philippine Is. *Philipp. J. Sci. (D)* 11: 195-217, 2 pls. (Psocids: pp. 197-203, pl. 1, figs. 1-10; pl. 2, figs. 11-15).

1918. New Neuropteroid Insects. *Bull. Mus. comp. Zool. Harv.* 62 (1): 1-22. 2 pls. (Psocids: pp. 3-5, pl. 1, fig. 1; pl. 2, figs. 19, 23, 24). North American and Australian spp.

1920. New Neuropteroid Insects. *Bull. Mus. comp. Zool. Harv.* 64 (3): 299-362, 7 pls. (Psocids: pp. 299-314, pl. 1, figs. 1, 2, 4, 6-8, 10, 11; pl. 2, figs. 14, 15, 17-19, 24; pl. 3, figs. 25, 28, 29, 31, 33, 34; pl. 7, fig. 79). Species from Singapore, Borneo, Philippines, Peru, Colombia, Brazil, North America.

1924. Descriptions of New Neuropteroid Insects. *Bull. Mus. comp. Zool. Harv.* 65 (12): 421-455, 4 pls. (Psocidae: pp. 422, 423, pl. 1, figs. 8, 9). Species from Jamaica, Peru, Porto Rico.

1929. A Classification of the Psocidae. *Psyche, Camb. Mass.* 36: 321-325. Proposed classification, keys to families, subfamilies and tribes.

1930a. Some new neotropical Neuropteroid insects. *Psyche, Camb. Mass.* 37 (2): 183-191, pl. 9. (Psocids: pp. 183-185, pl. 9, figs. 1, 3-5). Species from Panama, Cuba, Florida, Honduras.

1930b. New Neuropteroid Insects from the United States. *Psyche, Camb. Mass.* 37: 223-233, pl. 12.

1931a. On some Psocidae from the Hawaiian Is. *Proc. Hawaii. ent. Soc.* 7 (3): 437-441, pls. VII-IX.

1931b. Some oriental Neuropteroid Insects. *Psyche, Camb. Mass.* 38 (1): 56-70, pl. 5. (Psocidae: pp. 56-58, pl. 5, fig. 3). *Ectopsocus aethiops* var. *bakeri* from Philippines.

1934. Supplementary Neuropteroid insects from the Malay peninsula and from Mt. Kinabalu, Borneo. *J.F.M.S. Mus.* 17: 567-578, 23 figs. Paper deals mainly with Neuroptera and Trichoptera, some psocid spp. recorded.

1937a. Philippine Neuropteroid Insects. *Philipp. J. Sci.* 63 (2): 125-174, 6 pls. (Psocids: pp. 125-134, pl. 1, figs. 2-10; pl. 2, figs. 17-19).

1937b. Neuropteroid Insects from Formosa. *Philipp. J. Sci.* 62 (3): 255-291, 3 pls. (Psocids: pp. 255-268, pl. 2, figs. 12, 14-16, 18; pl. 3, figs. 22, 23, 25-28, 30).

1938a. New native Neuropteroid Insects. *Psyche, Camb. Mass.* 45: 72-79, pl. XI. (Psocids: p. 72).

1938b. Further Neuropteroid insects from Malaya. *J.F.M.S. Mus.* 18: 220-235, 17 figs. (Psocids: pp. 220-221).

1938c. New West Indian Neuropteroid Insects. *Rev. Ent. Rio de J.* 9: 285-304, 29 figs. (Psocids: pp. 285-289, figs. 1-3, 19).

1939a. Neuropteroid Insects from the Philippines. *Philipp. J. Sci.* 69 (2): 133-145, 1 pl. (Psocidae: pp. 133-136, pl. 1. figs. 1, 2, 9).

1939b. New genera and species of Neuropteroid Insects. *Bull. Mus. comp. Zool. Harv.* 85 (7): 439-504, 9 pls. (Psocidae: pp. 439-441, pl. 1, figs. 1, 12; pl. 2, fig. 21). Australian spp.

1941. New Neuropteroid insects from the Antilles. *Mem. Soc. cubana Hist. nat.* 15 (4): 385-402, pls. 43-45. (Psocidae: pp. 385-394, pl. 43, figs. 1, 2, 5, 6, 8-10; pl. 44, figs. 11, 15-17, 20, 21, 22, 24).

1942. Insects of Guam. I. Neuropteroid Insects of Guam. *Bull. Bishop Mus. Honolulu* 172: 25-30, 1 fig. (Psocidae: pp. 25-29, figs. la, lc-le, lg, lh).

1947. Some Neuropterous Insects from Szechwan, China. *Fieldiana, Zool.* 31: 97-107, 13 figs. (Psocidae: p. 100). *Psocus gibbosus* recorded.

Bastmann, H.

1913. Bidrag till kannedomen om Nylands copeognather. *Medd. Soc. Fauna Fl. fenn.* 39: 73.

1914. (Minutes of meeting). *Medd. Soc. Fauna Fl. fenn.* 40: 243. *Caecilius atricornis* recorded.

Beaumont, J. de

1952. Psocoptères de Suisse romande. *Bull. Soc. vaud. Sci. nat.* 65 (281): 293-300.

Becker-Migdisova, E. E.

1953a. First discovery of the Psocoptera of the Kuznetsk Basin. *Dokl. obsch. Sobr. Ak. Nauk. S.S.S.R.* 90 (2): 279-282, 1 fig. (In Russian).

1953b. Obzar faun ravnokrylykh i senoidou erunakovska i kuznetskai svit kuzbassa. (Review of the Homoptera and Copegnatha of the Erunakov and Kuznetsk formations of the Kuznetsk Basin). *Dokl. obsch. Sobr. Ak. Nauk. S.S.S.R.* 90 (1): 97-100.

1960. Palaeozoic Isoptera of the U.S.S.R. and phylogeny problems of the order. *Paleont. J.* 3: 28-42, 10 figs.

1961. *In*: Rodenorf, B.B., Martynova, O.M. and Becker-Migdisova, E. E. *Palaeozoic Insects of Kuznetsk Basin.* Moscow. 674 pp., 40 pls., 541 figs. (Psocoptera: pp. 271-286, figs. 203-214).

1962. Some New Heteroptera and Homoptera. *Paleont. J.* 1: 89-104, 17 figs. (Psocoptera: pp. 101-103, figs. 16, 17).

Becker-Migdisova, E. E. and **Vishnyakova,** V. N.

1962. "*Principles of Palaeontology.*" Moscow. (Psocoptera: pp. 226-235, figs. 678-707).

Belche, G.

1866. Notice sur l'histoire naturelle du district de Radomysl. *Bull. Soc. Nat. Moscou* 39 (1): 491-526. (Psocids: p. 511).

Belton, C. H.

1950. Note on some insect pests in stored products. *N.Z.J. Sci. Tech.* (A) 32 (1): 44.

Berendt, G.

1856. See Hagen, H. A., 1856.

Bergemann, H.

1929. Houtluizen (Psocidae). *Meded. Proefst. Malang.* 71: 15.

Berland, L.

1935. Premiers resultats de mes recherches en avion sur la faune et la flore atmosphériques. *Ann. Soc. ent. Fr.* 104: 73-96.

Bernard, F.

1934. Observations sur les proies de quelques Hyménoptères. *Bull. Soc. ent. Fr.* 39: 247-250. (Psocids: p. 250).

Bertkau, P.

1883a. Ueber den Geschlechtsdimorphismus und die Speicheldrűsen der Psociden und ein Verzeichniss der bisher bei Bonn Beobachten Arten. *Ver. naturh. ver. preuss. Rheinl.* 39: 127-133.

1883b. Über einen auffallenden Geschlechtsdimorphismus bei Psociden nebst Beschreibung einiger neuer Gattungen und Arten. *Arch. Naturgesch.* 49: 97-101, pl. 1.

1886. Über die geographische Verbreitung einiger Psociden. *S.B. niederrhein. Ges. Nat. -u Heilk.* 43: 68.

1890. Über einen Psociden der die Aachen als Hausplage aufgetreten war. *Verh. natur. Ver. preuss. Rheinl.* 47: 63-66.

Betts, M. M.

1956. A list of insects taken by titmice in the forest of Dean (Gloucestershire). *Ent. mon. Mag.* 92: 68-71. (Psocoptera: p. 68). 5 spp. of Psocoptera mentioned.

Beuthin, H.

1875. Verzeichnis der Pseudoneuropteren und Neuropteren der Ungegend von Hamburg. *Verh. Ver. naturw. Unterh. (Heimatforsch.) Hamb.* 1: 122-126. (Psocids: p. 124). 5 spp. listed.

Bey-Bienko, G. Y.
1961. On some regularities in changes of the virgin steppe invertebrate fauna under cultivation. *Ent. Obozr.* 40 (4): 763-775. (Psocid: p. 768). *Caecilius gynapterus.*
1964. See Vishnyakova, V. N. 1964.

Bhasin, G. D.
1953. See Roonwal, M. L. et al. 1953.

Bianchi, W. L.
1904. See Jacobson, G. G. and Bianchi, W. L. 1904.

Bignell, G. C.
1903. *Psocus quadrimaculatus* Latr. near Saltash. *Ent. mon. Mag.* 39: 42. Record for Cornwall, England.

Billberg, G. J.
1820. *Enumeratio insectorum in Museo Billberg.* Holmiae. (Psocid: Part 4: 94). *Psylla pulsatoria* (L.).

Biro, L.
1901. Pokhalo — Sovo Psocidae (Spinnende Psocide). *Rovart. Lapok* 8: 204-205. (Schröder, C. 1902, *Allg. Z. Ent.* 7 (6): 123 is a review of this).

Blackwall, J.
1867. On the asserted connection of *Atropos* with the "death watch." *Ent. mon. Mag.* 4: 19-20. This paper is followed by a note by R. McLachlan (see McLachlan 1867a).
1891. (Exhibit of specimen of *Atropos pulsatoria*). *Proc. ent. Soc. Lond.* 1891. xxxii-xxxiii. In connection with sound production.

Blagoveshchensky, D. I.
1959. On the problem of Mallophaga evolution. *Zool. J.* 38 (3): 432-442. (In Russian with English summary).

Blair, C. R.
1941. Studies in the biology of the booklouse *Liposcelis divinatorius* (Mull.). *Bull. La. Univ.* (*N.S.*) 33: 98.

Blair, K. G.
1928. *Lepidilla kelloggi* Rib. (*Pteroxanium squamosum* End.) *Ent. mon. Mag.* 64: 269. Found in Westmorland and Yorkshire, England.
1932. Collecting notes from mid Perthshire. *Ent. mon. Mag.* 68: 209-213. (Psocids: p. 212). 6 spp. mentioned.
1950. Neuroptera of the Isle of Wight. *Proc. Is. Wight nat. Hist. Soc.* 4 (5): 157-162. (Psocoptera: p. 158). List.

Blanchard, E.
1851. *In* Gay, C., *Historia fisica y politica de Chile segun documentos adquiridos en esta republica durante doze anos de residencia en ella y publicado bajo los auspicios del suprema gobierno.* With Atlas in Folio. Paris and Santiago. (Psocids: 6: 92-96, pl. 2, fig. 1). 5 spp. treated, all placed in *Psocus.*

Blankaart, S.
1688. *Schou-Burg der Ruspen, Wormen, Ma'den, en Vliegende Dierkens daar uit voorkomende.* Amsterdam. 342 pp., 22 pls. (Psocid: p. 167, pl. 14, F).

Blomquist, V. H.

1958. See Daly, A. W., Blomquist, V. H. and Hodges, F. A. 1958.

Boffa, G. D.

1949. *Gli insetti diannosi all'agricolturi e i moderni metodi e mezzi di lotta.* Milan. 978 pp. illustr. (Corrodentia: p. 96). *Troctes divinatorius.*

Borgmeier, T.

1928a. Ein interessantes Copeognathen-Gespinst aus Brasilien. *Ent. Mitt.* 17: 155-161, 1 fig. Footnote on p. 155 by Editor that web was probably that of Hymenopteron resembling that of Braconid *Meteorus.*

1928b. Sobre um casulo curiosa de um Copeognato brasiliero. *Bol. Mus. nac. Rio de J.* 4 (3): 59-65, 2 pls.

Boring, A. M.

1913. The odd chromosome in *Cerastipsocus venosus. Biol. Bull. Woods Hole* 24: 125-172, pls. i, ii.

Borner, C.

1904. Zur Systematik der Hexapoden. *Zool. Anz.* 27 (16/17): 511-533, 4 figs. Bőrner's classification.

1929. Mandibeln und Maxillen bei Psociden, Thysanopteren und Rhynchoten. *Z. wiss. Insekt-Biol.* 24: 108-116, 3 figs.

Borror, D. J. and **DeLong,** D. M.

1954. *An introduction to the study of insects.* New York. i-xi, 1030 pp., illustr. (Psocoptera: pp. 169-179, figs. 14-1—14-7).

Box, H. E.

1953. *List of sugar-cane insects. A synonymic catalogue of the sugar-cane insects and mites of the world, and of their insect parasites and predators, arranged systematically.* London. 101 pp. (Corrodentia: p. 56). *Cyptophania hirsuta.*

Bradley, R.

1721. *A philosophical account of the works of nature, in the mineral, vegetable and animal parts of the creation.* London. (Psocid: p. 154).

1739. *A philosophical account of the works of nature, in the mineral, vegetable and animal parts of the creation.* London. (Psocid: p. 216, pl. 27, fig. 3).

Brauer, F.

1857. *Neuroptera austriaca; die im Erzhergothum Oesterreich bis jetzt aufgefunden Neuropteren* etc. Wien. i-xxiii, 80 pp. 5 pls. (Psocids: pp. 32-34).

1865. Vierter Bericht über die auf der Weltfahrt der kais. Fregatte Novara gesammelten Neuropteren. *Verh. zool. — bot. Ges. Wien* 15: 903-908. (Psocids: p. 908).

1868a. *Reise der Osterreichischen Fregatte Novara um die Erde in den Jahren* 1857, 1858, 1859. Zool. Theil. Band II, Abt. 1A (4) Neuropteren. 105 pp. 2 pls. Vienna. (Psocids: pp. 50-51).

1868b. Verzeichniss der bis jetzt bekannten Neuropteren im Sinne Linnes. Erster Abschnitt. *Verh. zool. — bot. Ges Wien* 18: 359-416. (Psocids: pp. 391-392).

1876. Die Neuropteren Europas, und insbesondere Oesterreichs, mit Rücksicht auf ihre geographische Verbreitung. *Festschr. zool. -bot. Ges. Wien* 4: 265-600. (Psocids: pp. 293-294, 271). (Review in *Ent. mon. Mag.* 14: 44).

1878. Verzeichniss der Neuropteren Deutschlands und Osterreichs II. Auszug die Neuropteren Europa's von Prof. Dr. Brauer, mit Zusätzen und Verbesserungen von ebendems. *Ent. Nachr.* 4 (7): 69-74, 85-90. (Psocids: pp. 86-87).

1885. Systematische-zoologische Studien. *S.B. Akad. Wiss. Wien* 91: 237-413, 1 pl.

1900. Über die von Prof. O. Simony auf den Canaren gefundenen Neuroptera und Pseudoneuroptera (Odonata, Corrodentia et Ephemeriidae). *S.B. Akad. Wiss. Wien* 109: 464-477. (Corrodentia: p. 467) 6 spp. listed.

Brethes, J.

1923. Un *Dorypteryx* nouveau de Buenos Aires. (Copeognatha) *Bull. Soc. ent. Fr.* 1923: 117-119, 2 figs.

Briggs, C. A.

1898. *Psocus major* Loens, in Surrey. *Ent. mon. Mag.* 34: 66.

Brimley, C. S.

1938. *The Insects of North Carolina.* Dep. Agric. North Carolina. (Psocids: pp. 44-46).

Brindle, A.

1963. The insects of the Malham Tarn area. Orthoptera, Psocoptera, Neuroptera and Mecoptera. *Proc. Leeds Phil. Lit. Soc.* 9 (2): 20-21. List.

Bristowe, W. S.

1941. *The Comity of Spiders.* London. Vol. 2. pp. i-xiv, 229-560, figs. 16-96, pls. XX-XXII. (Psocoptera and predators: p. 296). Spiders preying on psocids.

Britten, H.

1926. Psocidae on the wing. *Ent. mon. Mag.* 52: 43. Species in flight at Oxford, England.

Britton, W. E.

1918. Seventeenth Report of the State Entomologist of Connecticut for the year 1917. *Bull. Conn. agric. Expt. Sta.* 203: 231-370, 4 figs., pls. I-XXXII. (Psocid: p. 339). *Troctes divinatorius* damaging corn.

Broadhead, E.

1946. The booklouse and other library pests. *British Book News* 1946: 77-81.

1947a. The characters of the genus *Liposcelis* (Corrodentia, Liposcelidae) and a further description of *Liposcelis formicarius* (Hagen) with notes on its affinities. *Proc. R. ent. Soc. Lond. (B)* 16 (3/4): 35-38, 1 fig.

1947b. A further description of *Liposcelis entomophilus* (Enderlein) (Corrodentia) (Liposcelidae), with a note on its synonymy. *Proc. R. ent. Soc. Lond. (B)* 16 (9/10): 109-113, 1 fig.

1947c. New species of *Liposcelis* Motschulsky (Corrodentia, Liposcelidae) in England. *Trans. R. ent. Soc. Lond.* 98 (3): 41-58, 1 pl., 9 figs.

1947d. The life history of *Embidopsocus enderleini* (Rib.) (Corrodentia) (Liposcelidae). *Ent. mon. Mag.* 83: 200-203.

1949. On the identity of the psocid *Cuixa canaria* Navas. *Ent. mon. Mag.* 85: 80.
1950a. Collecting Psocoptera. *Leafl. Amat. Ent. Soc.* 21, 4 pp., 4 figs.
1950b. A revision of the genus *Liposcelis* Motschulsky with notes on the position of this genus in the order Corrodentia and on the variability of ten *Liposcelis* species. *Trans. R. ent. Soc. Lond.* 101 (10): 335-388, 3 pls., 28 figs.
1952a. A comparative study of the mating behaviour of eight *Liposcelis* species. *Trans. 9th. int. Congr. Ent. Amsterdam* 1951: 380-382, 1 fig.
1952b. The nomenclature of some British Psocoptera. *Ent. mon. Mag.* 88: 83. Use of "*Liposcelis*" and "*Troctes*" discussed; identity of *Atropos kidderi.*
1954a. A new parthenogenetic psocid from stored products, with observations on parthenogenesis in other psocids. *Ent. mon. Mag.* 90: 10-16. *Liposcelis obscurus.*
1954b. See Thornton, I. W. B. and Broadhead, E. 1954.
1954c. The infestation of warehouses and ships' holds by Psocids in Britain. *Ent. mon. Mag.* 90: 103-105.
1955. Two new psocid species from stored products in Britain. *Proc. R. ent. Soc. Lond. (B)* 24 (1/2): 7-12, 13 figs. *Liposcelis albothoracicus, Lepolepis bicolor.*
1956. A heavy infestation of *Lachesilla pedicularia* (L.) (Corrodentia, Pseudocaeciliidae). *Ent. mon. Mag.* 92: 38.
1957. An ecological study of mixed species populations exploiting a common resource. *J. anim. Ecol.* 26 (2): 519. Species of Psocoptera on larch trees in England. (cf. Broadhead, E. 1958a).
1958a. The psocid fauna of Larch trees in Northern England—an ecological study of mixed species populations exploiting a common resource. *J. anim. Ecol.* 27 (2): 217-263, 5 figs. (cf. Broadhead, E. 1957).
1958b. Some records of animals preying upon Psocids. *Ent. mon. Mag.* 94: 68-69.
1961. The biology of *Psoquilla marginepunctata* (Hagen) (Corrodentia, Trogiidae). *Trans. Soc. Brit. Ent.* 14: 223-236, 4 figs.

Broadhead, E. and **Datta,** B.

1960. The taxonomy and ecology of British species of *Peripsocus* Hagen (Corrodentia, Pseudocaeciliidae). *Trans. Soc. Brit. Ent.* 14 (5): 131-146, 15 figs.

Broadhead, E. and **Hobby,** B. M.

1944a. Studies on a species of *Liposcelis* (Corrodentia, Liposcelidae) occurring in stored products in Britain. Pt. I. *Ent. mon. Mag.* 80: 45-59, figs. 1-20. *L. granicola.*
1944b. Studies on a species of *Liposcelis* (Corrodentia, Liposcelidae) occurring in stored products in Britain. Pt. II. *Ent. mon. Mag.* 80: 163-173, figs. 21-22. *L. granicola.*
1945. The booklouse. *Discovery* 6 (5): 142-147, figs. 1-10.

Broadhead, E. and **Thornton,** I. W. B.

1955. An ecological study of three closely related psocid species. *Oikos* 6 (1): 1-50, 19 figs. *Elipsocus mclachlani, E. westwoodi* and *E. hyalinus* in England.

Broadhead, E. and **Wapshere,** A. J.

1960. Notes on the eggs and nymphal instars of some psocid species. *Ent. mon. Mag.* 96: 162-166, 14 figs. Several species in England.

Brohmer, P.

1920. See Enderlein, G. 1920a.
1927. See Enderlein, G. 1927.

Brown, A. W. A.

1934. A contribution to the insect fauna of Timagami. *Canad. Ent.* 46: 206-211, 220-231, 242-252, 261-267. (Corrodentia: p. 222). Two spp. listed from Lake Timagami area, Canada.

Brown, C. D.

1942. Temperature and humidity in the ecology of *Liposcelis divinatorius* (Műller) (Corrodentia, Atropidae). *Iowa St. Coll. J. Sci.* 26: 175-176.

Brown, J. M.

1928. Psocoptera from Merionethshire. *Ent. mon. Mag.* 64: 15, 91. 13 spp. listed.

1932. Psocoptera etc., in Norfolk. *Ent. mon. Mag.* 68: 53. 14 spp. listed.

1936. Yorkshire Psocoptera. *Naturalist Lond.* 953: 135-139. 31 spp. listed.

Brues, C. T.

1927. Observations on wood-boring insects, their parasites and other associated insects. *Psyche, Camb., Mass.* 34: 73-90. (Psocids: p. 78). 4 spp. mentioned.

Brues, C. T., **Melander,** A. L. and **Carpenter,** F. M.

1954. Classification of Insects. *Bull. Mus. comp. Zool. Harv.* 108: i-v, 1-917, 1219 figs. (Corrodentia: pp. 125-129, 810-812, figs. 155-166, 1173-1178). Keys to families (existing, pp. 125-129, extinct, pp. 810-812).

Bryan, E. H.

1929. See Swezey, O. H. and Bryan, E. H. 1929.

Burgess, E.

1877. On the structure of the head of *Atropos. Psyche, Camb., Mass.* 2: 87-89. (See Scudder, S. H. 1877).

1878. The anatomy of the head and the structure of the maxilla in the Psocidae. *Proc. Boston. Soc. nat. Hist.* 19: 291-296, pl. 8.

Burmeister, H.

1839. *Handbuch der Entomologie.* Berlin. 1832-1855, 5 vols. (Psocoptera: Vol. 2, Abt. 2, Heft 2).

Busvine, J. R.

1951. *Insects and Hygiene.* London. pp. i-xiv, 482 pp., 1 frontis., 57 figs. (Psocoptera: pp. 411-415).

Butler, G. D.

1961. Insects and other arthropods from Laysan Island. *Proc. Hawaii. ent. Soc.* 17 (3): 379-387. (Corrodentia: p. 381). 3 spp. listed.

Butler, G. D. and **Usinger,** R. L.

1963. Insects and other Arthropods from Kure Island. *Proc. Hawaii. ent. Soc.* 18 (2): 237-244. (Corrodentia: p. 240). *Ectopsocus perkinsi* Banks listed.

Call, R. E.

1897. See Banks, N. 1897.

Campbell, J. W.

1928. Notes on egg-laying and mating habits of *Myopsocus novae-zelandiae* Kolbe. *Bull. Brooklyn ent. Soc.* 23: 124-128, 2 figs.

Candura, G. S.

1932. Contributi alla conoscenza biologica del *Troctes divinatorius* Műller. *Boll. Zool. Napoli* 3: 177-184, 1 fig.

1933. Studi e ricerche sugl'insetti viventi nelle paste alimentari. Contributi 1-14. *Boll. Soc. Nat. Napoli* 44: 159-203. (Corrodenti: Contr. XIII. pp. 194-195). *Troctes divinatorius*.

Carpenter, F. M.

1926. Fossil Insects from the Lower Permian of Kansas. *Bull. Mus. comp. Zool. Harv.* 67: 437-444, 3 pls. (Copeognatha: pp. 440-441, pl. 2, fig. 1; pl. 3, fig. 2).

1932. The Lower Permian insects of Kansas. 5: Psocoptera and additions to the Homoptera. *Amer. J. Sci.* 24: 1-22, 11 figs.

1933. The lower Permian insects of Kansas. 6: Delopteridae, Protelytroptera, Plecoptera and a new collection of Protodonata, Megasecoptera, Homoptera and Psocoptera. *Proc. Amer. Acad. Arts Sci.* 68 (11): 411-503, 29 figs. 1 pl. (Psocoptera: pp. 443-461, figs. 13-16).

1938. Structure of Permian Homoptera and Psocoptera. *Nature, Lond.* 141: 164-165.

1939. The lower Permian insects of Kansas. 8: Additional Megasecoptera, Protodonata, Odonata, Homoptera, Psocoptera, Protelytroptera, Plecoptera and Protoperlaria. *Proc. Amer. Acad. Arts Sci.* 73 (3): 29-70, 27 figs. 2 pls. (Psocoptera: pp. 54-57, figs. 19-22).

1954. See Brues, C. T., Melander, A. L. and Carpenter, F. M. 1954.

Carpenter, F. M. and **Darlington,** P. J.

1954. Nathan Banks, a biographic sketch and list of publications. *Psyche, Camb., Mass.* 61 (3): 81-110, 1 pl.

Carpenter, W. B.

1843. *The popular cyclopaedia of natural science.* London. (Psocids: p. 677).

Carr, J. W.

1914. The Psocidae of Nottinghamshire. *Entomologist* 47: 95-96. List of spp. taken in Nottinghamshire.

Carruthers, R. H.

1936. See Weiss, H. B. and Carruthers, R. H. 1936.

1937. See Weiss, H. B. and Carruthers, R. H. 1937.

Cazal, P.

1948. Les glandes endocrines rétrocérébrales des Insectes. (Etude morphologique). *Bull. biol., Paris, Suppl.* 32: 1-227, 186 figs. (Psocids: especially pp. 64-69, figs. 52-55).

Cederjhelm, J.

1798. *Fauna Ingricae Prodromus exhibens methodicam descriptionem Insectorum agri Petropolensis praemissa Mammalium, Avium, Amphibiorum et Piscium enumeratione.* Lipsiae. (Hemerobius: pp. 141-142).

Chaine, J.

1902. See Kunstler, J. and Chaine, J. 1902.

1903a. See Kunstler, J. and Chaine, J. 1903a.

1903b. See Kunstler, J. and Chaine, J. 1903b.

Chandra, A.

1953. See Roonwal, M. L. et al. 1953.

Chaney, W.

1867. The Death Watch. *Hardwicke's Science Gossip.* 1867: 29-30. Ticking sound.

Chapman, P. J.

1930. Corrodentia of the United States of America I. Suborder Isotecnomera. *J.N.Y. ent. Soc.* 38: 219-290, 319-402, pls. XII-XXI.

Chapman, P. J. and **Nadler,** A. M.

1928. *In* Leonard, M. D. A list of the Insects of New York. *Mem. Cornell agric. Exp. Sta.* 101, 1121 pp. (Corrodentia: pp. 60-63).

Chapman, T. A.

1916. *Ectopsocus briggsi* (McLach.) Psocoptera. *Entomologist* 49: 62-63.

Chopard, L.

1948. Atlas des libellules de France, Belgique, Suisse. *Nouv. Atlas Ent. Paris* 3, 137 pp., 47 figs., 12 pls. (Psocoptera: pp. 95-108).

Chou, M., **Chung,** C. and **Wei,** H.

1953. *Compendium of agricultural pests in North China.* Shanghai. 274 pp. illustr. (in Chinese) (Corrodentia: p. 21).

Chung, C.

1953. See Chou, M., Chung, C. and Wei, H. 1953.

Cockerell, T. D. A.

1916. Insects in Burmese Amber. *Amer. J. Sci.* 42: 135-138, 4 figs. (Psocids: pp. 136-138, figs. 2, 3).

1917. The Fauna of Boulder County, Colorado. IV. *Bull. Univ. Colo.* 17: 21-25. (Psocid: p. 22). *Myopsocus coloradensis* Banks recorded.

1919. Insects in Burmese Amber. *Entomologist* 52: 241-243, 3 figs.

1921. Fossil Arthropods in the British Museum. VI. Oligocene Insects from Gurnet Bay, Isle of Wight. *Ann. Mag. nat. Hist.* 7: 453-480, 50 figs. (Corrodentia: p. 480, fig. 50). *Psocus acourti.*

1929. The psocid family Caeciliidae. *Entomologist* 62: 19. Name of family discussed; Peripsocidae suggested as alternative.

Collart, A.

1950. Un Psocoptère nouveau pour la faune de Belgique: *Dorypteryx pallida* Aaron. *Bull. (Ann.) Soc. ent. Belg.* 86: 169-170.

Conci, C. and **Franceschi,** T.

1953. Un curioso caso di dermatite umana provocata forse da Psocotteri. *Boll. Soc. ent. Ital.* 83: 17-20. *Lepinotus reticulatus, Liposcelis mendax.*

Cooley, R. A.

1914. Eleventh Annual Report of State Entomologist of Montana. *Bull. Mont. agric. Exp. Sta.* 98: 123-136. Mention of *Liposcelis divinatorius.*

Cope, O. B.

1940a. The Morphology of *Psocus confraternus* Banks (Psocoptera: Psocidae). *Microentomology* 5 (4): 91-115, figs. 38-53.

1940b. The morphology of *Esthiopterum diomedeae* (Fabricius) (Mallophaga). *Microentomology* 5 (5): 117-142, figs. 54-66.

1942. The Morphology of the Psocoptera and Mallophaga. *Abstr. Diss. Stanf. Univ.* 17 (49): 3-6. Most of contents of this paper is to be found in Cope, O. B. 1940a.

Coquebert, A. J.

1799. *Illustrata Inconographica Insectorum, quae in Musaeis parisinis observavit et in lucem edidit Joh. Christ. Fabricius, praemissis eiusdem descriptionibus. Accedunt species plurimae, vel minus vel nondum cognitae.* Paris. (Psocids: pt. 1, pp. 8-14).

Corbett, G. H.
1933. Annual Report, Division of Entomology, for year 1932. *Gen. Ser. Dep. Agric. S.S. & F.M.S.* 14: 39-52.

Corbett, G. H. and **Hargreaves,** E.
1915. *Vulturops floridensis,* a new member of the psocid sub-family Vulturopinae from the United States. *Psyche, Camb., Mass.* 22 (4): 142-143, pl. xi.

Corporaal, J. B.
1926. (Minutes of meeting). *Tijdschr. Ent.* 69: XCVII-CI. (Psocid: p. C). 1 sp. recorded as new to Holland.

Costa, A.
1885. Diagnosi di nuovi Artropodi della Sardegna. *Boll. Soc. ent. Ital.* 17: 240-255. (Psocids: p. 243).
1888. Notizie ed osservationi sulli Geo-Fauna Sarda. Memoria Quarta. *Atti Accad. Sci. fis. nat. Napoli* (2) 1(13): 1-31. (Psocids: pp. 5, 15-17).

Costa Leite, I. da
1952. See Costa Lima, A. da, and Costa Leite, I. da, 1952.

Costa Lima, A. da,
1939. *Insectos do Brazil.* 1° Tomo. Rio de Janiero, i-x, 470 pp., 218 figs. (Psocoptera: pp. 335-349).

Costa Lima, A. da, and **Costa Leite,** I. da
1952. Um Psocidea da familia Amphientomidae na America do Sol. *Mem. Inst. Osw. Cruz* 50: 271, 2 pls.

Cragg, J. B.
1962. Zoological Notes. *J. Anim. Ecol.* 31: 420. Lists species from larch and birch at Craig Cerrig Gleisiad Nature Reserve, Wales.

Craighead, F. C.
1950. *Insect enemies of eastern forests.* Washington. 657 pp. illustr. (Corrodentia: p. 81).

Crampton, G. C.
1916. The lines of descent of the lower pterygotan insects, with notes on the relationships of the other forms. *Ent. News* 27: 244-258, 297-307. (Psocids: p. 299).
1918. The genitalia and terminal abdominal structures of male Neuroptera and Mecoptera with notes on the Psocidae, Diptera and Trichoptera. *Psyche, Camb., Mass.* 25: 47-59, pls. I, II.
1919. Notes on the ancestry of the Diptera, Hemiptera and other insects related to the Neuroptera. *Trans. ent. Soc. Lond.* 1919 (1/2): 93-118, 2 figs.
1920a. Addendum to Crampton, G. C. 1919. *Trans. ent. Soc. Lond.* 1920: 466, 1 fig.
1920b. Some anatomical details of the remarkable winged zorapteron, *Zorotypus hubbardi* Caudell, with notes on its relationships. *Proc. ent. Soc. Wash.* 22: 98-106, 1 pl.
1920c. Notes on the lines of descent of lower winged insects. *Psyche, Camb., Mass.* 27: 116-127.
1921a. A phylogenetic study of the venation of the fore wings of the Homoptera, Thysanoptera, Psocida, Zoraptera, Neuroptera, Embiidae, Plecoptera and Hadentomoidea, with notes on the Hymenoptera and Coleoptera. *Ent. News* 32: 97-105, 135-140, 1 pl.

1921b. The sclerites of the head and the mouthparts of certain immature and adult insects. *Ann. ent. Soc. Amer.* 14 (2): 65-103, pls. II-VIII. (Psocids: p. 94).

1921c. A further comparison of the wings of Zoraptera, Psocids and Aphids from the standpoint of phylogeny. *Canad. Ent.* 53 (5): 110-117, pl. III.

1922. Notes on the relationships indicated by the venation of the wings of insects. *Canad. Ent.* 54: 206-216, 222-235, pls. 5-9. (Psocids: especially on p. 222-225).

1923. A phylogenetic comparison of the maxillae throughout the orders of insects. *J.N.Y. ent. Soc.* 21: 91-92, fig. 73, pl. 17.

1924. The Phylogeny and Classification of Insects. *J. Ent. Zool.* 16: 33-46.

1926. A comparison of the neck and pro-thoracic sclerites throughout the orders of insects from the stand-point of phylogeny. *Trans. Amer. ent. Soc.* 52: 199-248, 8 pls.

1927. *Eugeron* and the ancestry of the Hemiptera, Psocids and Hymenoptera. *Bull. Brooklyn ent. Soc.* 22: 1-15.

1928a. The grouping of the insect orders and their lines of descent. *Entomologist* 61: 82-85, pl. VI.

1928b. The interrelationships and lines of descent of living insects. *Psyche, Camb., Mass.* 45: 165-181, 1 pl. (Psocids: p. 173).

1929. The terminal abdominal structures of female insects, from the standpoint of phylogeny. *J.N.Y. ent. Soc.* 37: 453-496, 8 pls. (Psocids: especially p. 472).

1932. A phylogenetic study of the head capsule in certain orthopteroid, psocoid, hemipteroid and holometabolous insects. *Bull. Brooklyn ent. Soc.* 27: 19-49, pls. IV-VIII.

Crowson, R. A.

1961. *Lepidilla kelloggi* Ribaga (Psocoptera) and *Centrotus cornutus* L. (Homoptera) in Scotland. *Ent. mon. Mag.* 97: 232. Mentions occurrence.

Cumber, R. A.

1959. The insect complex of sown pastures in the North Island. VI. The Psocoptera and Neuroptera as revealed by summer sweep-sampling. *N.Z.J. Agric.* 2 (5): 898-902, 2 figs. (Psocoptera: pp. 898-900, fig. 1). Lists 7 spp.

Curran, C. H.

1925. Descriptions of two insects found in imported foodstuffs. *Canad. Ent.* 57 (12): 292-293, figs. A, B. (Psocids: p. 292, fig. B).

Curtis, J.

1837. *British Entomology*. London. 1823-1840. (Psocids: Pt. 14: 648-651).

Dale, C. W.

1890. Insects in the Scilly Is. *Ent. mon. Mag.* 26: 328. *Caecilius dalii* mentioned.

1907. *Catalogue of British Orthoptera, Neuroptera and Trichoptera.* Colchester. 15 pp. (Psocids: p. 9).

Dale, P. S.

1954. A list of pests of plants recorded from Western Samoa. *W. Samoa Dep. Agr. Forests and Fisheries Information C.* 4 (8-9): 12-14. (Corrodentia: p. 14). *Liposcelis* in stored products.

Dalman, J. W.

1823. *Analecta Entomologica.* Holmiae. (Psocids: p. 98).

Daltry, H. W.
1929. A list of Staffordshire Psocoptera. *Trans. N. Staffs. Fld. Cl.* (1928-1929) 63: 89. Lists 11 species.

Daly, A. W. **Blomquist,** V. H. and **Hodges,** F. A.
1958. Identification of miscellaneous insects by the micromorphology of the exoskeleton. *J. Assoc. Official Agr. Chem.* 41 (1): 206-220, pls. I-VII. (Psocids: pp. 217-218, pl. III).

Dammerman, K. W.
1926. See Harny, H. H. 1926b.

Damph, A.
1924. See Enderlein, G. 1924b.

Danks, L.
1950a. Novyi vid senoeda. Psocopteres-*Philotarsus badonneli* Danks sp.n. ♀. *Goz. Muzei Prirody Riga LSSR* 1. 2pp., 6 figs.
1950b. Senojedy Suchumskoja botaniczeskoja sada. *Goz. Muzei Prirody Riga LSSR*. 2. 3pp. 4 figs.
1950c. Materially k faune senojedow (Psocoptera) Latwijskoj SSR. *Goz. Muzei Prirody Riga LSSR*. 3, 4 pp.
1955. Psocoptera of the Batum and Sochi Botanical Gardens. *Ent. Obozr.* 34: 180-184, 6 figs. (In Russian). 12 spp. listed, one new.
1956. Kerpu utu sparnu dzislojuma mainiba un izmiruso sugu uzstadisona. *Latv. PSR Zinat. Akad. Vestis* 5 (106): 69-74, 16 figs.
1957. Psocoptera of Georgia. Theses of addresses of the 3rd Congress of the All-Union Entomological Society. *Izdatelstwo Akad. Nauk. SSSR. Leningrad.* (Psocoptera: pp. 7-8).
1958. Issledovaniya Po Faune Senoyedov Latviiskoy SSR. (Studies on the Psocopteran fauna of Latvia). *Trans. Inst. Biol. Acad. Sci. Latvia SSR.* 5: 111-118, 6 figs.
1959. Zur Kenntnis der Staublausefaune (Psocoptera) der Estnischen SSR. *Entomol. Sbornik I. In-t zool. i bot. A.N. Estonskoj SSR.* 1: 147-155. (In Russian with German summary).
1960a. Die Psocopteren gesammelt in Karkato-Ukraine im Jahre 1959. *Latv. Ent.* 2: 18-20.
1960b. Neue Angaben über die Psocopterenfauna der Sowjetunion. *Latv. Ent.* 1: 29-33, 2 figs. (Summaries in Russian and German).
1961. *Stenopsocus stigmaticus* — a new Psocoptera species in the fauna of Latvia. *Latv. Ent.* 3: 62-63. (In Russian with English summary).
1962. Über die Psocopteren aus dem. Ilmen-Reservat. *Latv.* 5: 57-58. (In Russian with German summary).
1964. O senoedah Voronezskogo Gosudarstwennogo zapowednika. (On Bark-lices at the Voronezh State Reserve). *Latv. Ent.* 8: 42-46. 23 spp. listed from Voronezh State reserve.

Darlington, P. J.
1954. See Carpenter, F. M. and Darlington, P. J. 1954.

Datta, B.
1960. See Broadhead, E. and Datta, B. 1960.

Davey, K. G.
1960. The evolution of spermatophores in insects. *Proc. R. ent. Soc. Lond. (A)* 35 (7/9): 107-113. (Psocoptera: p. 109). Refers to spermatophores in psocids, as from Finlayson, L. H. 1949.

Davies, R. G.
1957. See Imms, A. D. 1957.

Davis, C.

1942. Hemiptera and Copeognatha from the Upper Permian of New South Wales. *Proc. Linn. Soc. N.S.W.* 67: 111-122, 24 figs.

Davis, C. J.

1952. New host and insect records from the Island of Hawaii. *Proc. Hawaii. ent. Soc.* 15 (1): 85-86. 3 spp. listed on *Acacia koaia.*

Delamere-Deboutteville, C.

1945. Notes biologique sur un Psocoptère *(Lepidilla kelloggi* Rib.) non encore signalé en Europe continentale. *Bull. Soc. ent. Fr.* 50: 52-54. Lists 10 spp. found in Finistère.

1952. See Badonnel, A. 1952.

DeLong, D. M.

1954. See Borror, D. J. and DeLong, D. M. 1954.

Derham, W.

1701. A letter to the Publisher concerning an insect that is commonly called the death-watch. *Phil. Trans.* 22: 832-834.

1704. A supplement to the account of *Pediculus pulsatorius* or Death Watch in Phil. Trans. No. 271 serving the more perfect natural history of that insect. *Phil. Trans.* 24: 1586-1594, pl. 291, figs. 4, 5.

Dispons, P.

1963. La biologie de genre *Empicoris* Wolff. Hemiptera, Heteroptera, Reduviidae (Emesinae, Stenolaemini). *Proc. XVI int. Congr. Zool. Washington,* 1: 4. Under webs of *Archipsocus ghesquierei.*

Donisthorpe, H.

1917. Attitudes of Wasps and Psocids in copulation. *Ent. Rec.* 29: 231-232.

Doubleday, H.

1866a. Ticking of the Death Watch. *Entomologist* 3: 65-66.

1866b. (Untitled). *Proc. ent. Soc. Lond.* 1866: iv.

Drenski, P.

1953. Über die Verbreitung der Copeognathen in Bulgarien. *Bull. Inst. zool. Acad. bulg. Sci. Sophia* 2: 377-382. (In Bulgarian with German summary). 6 spp. listed.

Dudich, E., **Pongracz,** S., **Fabian,** G. and **Iharos,** A.

1943. Bars vármegye Neuropteroidea-faunájának alapvetése. (Outline of the fauna of the Neuropteroids of Bárd Department). *Math. term. Kozl.* 39 (6): 1-46, 1 pl. (Copeognatha: pp. 15-16). Lists 12 spp.

Durham, J. W.

1962. See Hurd, P. D. et al. 1962.

Dziedzielewicz, J.

1867. Wykaz owadów siatkoskrzydlych (Neuroptera). *Spraw. Kom. fisjogr. Krakow* 1: 158-165.

1883. Sieciǿówki (Neuroptera) zebrane w okolicach Kolomyi i nad Dniestrem w.r. 1882. *Spraw. Kom. fizjogr. Krakow* 17 (II): 244-252. (Psocidae: p. 250). *Psocus longicornis* and *Ps. nebulosus* listed.

1891. Przeglad fauny krajowej owadów siatkoskrzydłych (Neuroptera, Pseudoneuroptera). *Spraw. Kom. fizjogr. Krakow* 26 (II): 26-151. (Psocidae: pp. 109-112). 12 spp. listed.

1895. Zestawiemie zapisków o owadach siatkoskrzydlych w Tatrach. Podczas pobytu w latach 1891-1892. *Spraw. Kom. fizjogr. Krakow* 30 (II): 1-40. (Psocidae: p. 33). 3 spp. listed.
1905. Siaciarki (Neuroptera genuina) i Prasiatnice (Archiptera) zebrane w ciagu lat 1902 i 1903. *Spraw. Kom. fizjogr. Krakow* 38: 104-125.
1908. Sieciarki (Neuroptera genuina) i Prasiatnice (Archiptera) zebrane w ciagu lat 1904 i 1905. *Spraw. Kom. fizjogr. Krakow* 42: 13-25.
1911. Owady siatkoskrzydle (Neuropteroidea) zebrane w Zachodnich Karpatach w roku 1909. *Spraw. Kom. fizjogr. Krakow* 45: 39-44.
1920. Owady siatkoskrzydlowate ziem Polski. (Insecta neuropteroidea Poloniae terrarum Czecc II.) *Rozpr. Mus. Dzied.* 4: 1-72, pls. I-III.

Eaton, A. E.

1879. An account of the Petrological, Botanical and Zoological collections made in Kerguelen's Land and Rodriguez during the Transit of Venus Expeditions in the year 1874-75. *Phil. Trans.* 168: i-vi, 1-579, pls. I-LV. (Psocidae: p. 248). *Rhyopsocus eclipticus* Hag.

Edmonds, R.

1834. The Death-Watch, the ticking of Anobium. *Ann. Mag. nat. Hist.* 7: 468-469. *Atropos lignarius, Termes pulsatorius.*

Edwards, B. A. B.

1950. A study of Tasmanian Psocoptera with Descriptions of New Species. *Pap. roy. Soc. Tasm.* 1949: 93-134, 117 figs.

Ehrmann, P.

1927. See Enderlein, G. 1927.

Eichler, W.

1938. *Thylacopsis madagascariensis, Brachymyrmex heeri* und *Ptidodactyla luteipes* in einem Dahlemer Gewächhaus. (Studien zur deutschen gewächausfauna II). *Zool. Anz.* 122: 330-333. (Psocoptera: pp. 330-331).
1952. Die Tierwalt der Gewächshauser. Leipzig. i-iv, 93 pp., 11 figs. (Psocoptera: p. 34).

Enderlein, G.

1900a. *Epipsocus ciliatus* Hagen, eine Psocide des Bernsteins und die recente peruanische *Epipsocus nepos* nov. sp. *Berl. ent. Z.* 45: 108-112, 3 figs.
1900b. Die Psociden fauna Perus. *Zool. Jb. Abt. Syst.* 14: 133-160, 4 figs., pls. 8, 9.
1901. Neue deutsche und exotische Psociden sowie Bemerkungen zur Systematik. *Zool. Jb. Abt. Syst.* 14: 537-548, pl. 35.
1902a. Neuroptera-Psociden (Einleitung). *Dr. O. Kranchers Entomologischem Jahrbuch* 1902. Leipzig.
1902b. Zur Kenntnis der Insekten Deutsch-Ostafrikas. Ergebnisse der Nyassassee- und Kingagebirge-Expedition der Heckmann-Wentzelstiftung. 2. Psociden aus Deutsch Ostafrikas. *Mitt. zool. Mus. Berl.* 2 (2): 7-16, fig. 3, pl. 5.
1903a. Die Copeognathen des indo-australischen Faunengebietes. *Ann. hist. -nat. Mus. hung.* 1: 179-344, 12 figs., pls. iii-xiv. Morphology, geographical distribution, keys, descriptions, list of spp.
1903b. Zur Kenntniss amerikanischer Psociden. I. Neue Gattungen und Arten südamerikanischer Psociden. II. Zwei neue nordamerikanischer *Troctes*-Arten. *Zool. Jb. Abt. Syst.* 18: 351-364, pls. 17 and 18.

1903c. Zur Kenntnis europäischer Psociden. I. *Tichobia* Kolbe — *Cerobasis* Kolbe — *Hyperetes* Kolbe, eine Entwicklungsreihe von *Hyperetes guestfalicus* Kolbe 1880. II. Zur Psocidenfauna Rügens. III. Zur Psocidenfauna von Dänemark und Schweden. *Zool. Jb. Abt. Syst.* 18: 365-382, figs. A-H, pl. 19.

1903d. Neue Copeognathen aus Kamerun. *Zool. Jb. Abt. Syst.* 19: 1-8, pl. 1.

1903e. Über die Morphologie, Gruppierung und systematische Stellung der Corrodentien. *Zool. Anz.* 26: 423-437, 4 figs.

1903f. Ein neuer Copeognathentypus, zugleich ein neuer deutscher Wohnungsschädling. *Zool. Anz.* 27: 76. *Nymphopsocus destructor.* (Same gen. et sp. as in *Zool. Jb. Abt. Syst.* 19: 727-732, of same date but this apparently is the first reference as suggested by footnote in *Zool. Jb.* reference [Enderlein 1903i]).

1903g. Über die Stellung von *Leptella* Reut. und *Reuterella* nov. gen., die Vertreter zweier neuer europäischer Copeognathensubfamilien. *Zool. Anz.* 27: 131-134.

1903h. *Micropsocus musae* (Kunstler and Chaine) eine vermeintliche Gallmücke *(Kiefferia musae* n.g., n.sp. Kunstler and Chaine 1902). *Zool. Jb. Abt. Syst.* 19: 288-292, 1 fig.

1903i. *Nymphopsocus destructor* Enderl. 1903, ein neuer Copeognathen-Typus, zugleich ein neuer deutscher Wohnungs-Schädling. *Zool. Jb. Abt. Syst.* 19: 727-732, figs. A-C, pl. 43.

1903j. Die Landarthropoden dervon der Tiefsee-Expedition besuchten antarktischen Inseln. I. Die Insekten und Arachnoideen der Kerguelen. II. Die Landarthropoden der antarktischen Inseln St. Paul und Neu-Amsterdam. *In Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia"* 1898-1899. 3: 199-269, 6 figs., pls. XXXI-XL. (I. pp. 199-248, 1 fig., pls. XXI-XXXVII; II. pp. 249-269, 5 figs. Pls. XXXVIII-XL). (Copeognatha: I. pp. 205 (list) 230-236, II. pp. 250 (list), 263-264). Psocids on pp. 230-236 consisting of re-descriptions and notes on *Rhyopsocus eclipticus* Hagen and *Troctes divinatorius* Mull. var. *kidderi* Hagen with fig. 1 of *Rhyopsocus* fore wing.

1904a. (Untitled note). *Zool. Zbl.* 11 (3): 84-89. Review of five 1903 and 1904 papers with an extended listing of the families and assigned genera of his classification mainly from 1903 paper on Indoaustralian Copeognatha *(Ann. hist. -nat. Mus. hung.* 1: 179-344, 12 figs., Pls. iii-xiv).

1904b. Die von Herrn Prof. Dr. Friedr. Dahl im Bismark-Archipel gesammelten Copeognathen nebst Bemerkungen über die physiologische Bedeuting des Stigmasackes. *Zool. Jb. Abt. Syst.* 20 (2): 105-112, pl. vii.

1905a. Eine neue Copeognathe von den Falklands-Inseln. 11. Beiträge zur Kenntnis antarktischer Landarthropoden. *Zool. Anz.* 29: 126-127. *Philotarsus falklandicus.*

1905b. Zwei neue beschuppte Copeognathen aus dem Bernstein. *Zool. Anz.* 29: 576-580, 6 figs. *Amphientomum* spp.

1905c. *Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901. No. 18. Morphologie, Systematik und Biologie der Atropiden und Troctiden sowie zusammenstellung aller bisher bekannten recenten und fossilen Formen.* 58 pp., 11 figs., 4 pls.

1906a. Die Copeognathen-Fauna Japans. *Zool. Jb. Abt. Syst.* 23: 243-256, pls. 10, 11.

1906b. Die australische Copeognathen. *Zool. Jb. Abt. Syst.* 23: 401-412, pl. 23.

1906c. Zehn neue aussereuropäische Copeognathen. *Stettin. ent. Ztg.* 67: 306-316, 1 fig. Species from Japan, Central America, Java, Tanganyika, Argentina, Peru, Canary Islands.

1906d. Einige Notizen zur Kenntnis der Copeognathen Nordamerikas. *Stettin. ent. Ztg.* 67: 317-320.

1906e. The scaly-winged Copeognatha (Monograph of the Amphientomidae, Lepidopsocidae and Lepidillidae in relation to their morphology and taxonomy). *Spolia zeylan.* 4: 39-122, 6 figs., pls. A-G. (Translated from German by A. Willey).

1906f. Zur Kenntnis der Copeognathen-Fauna Westpreussens. *Ber. westpreuss. bot. -zool. Ver.* 28: 71-88, 6 figs.

1907a. Die Copeognathen Javas. *Notes Leyden Mus.* 29: 107-126, 6 figs. Includes list of spp. from Java.

1907b. Copeognatha. *In* Michaelsen, W. und Hartmeyer, R. *Die Fauna Südwest-Australiens. Ergebnisse der Hamburger Südwest-Australischen Forschungsreise 1905.* Jena. (Copeognatha: 1: 233-240, 6 figs). Includes list of spp. known from Australia.

1907c. Aussereuropäische Copeognathen aus dem Stettiner Museum. *Zool. Jb. Abt. Syst.* 24: 81-90, pl. 6.

1907d. *Actenotarsus,* eine neue Copeognathengattung aus Spanien. *Zool. Jb. Abt. Syst.* 25: 503-506, pl. 19.

1907e. *Troctes entomophilus,* ein neuer Insekten-liebhaber aus Columbien. *Stettin ent. Ztg.* 68: 34-36, 1 fig.

1907f. Neue Beiträge zur Kenntnis der Copeognathen Japans. *Stettin. ent. Ztg.* 68: 90-106, 2 figs. Lists spp. from Japan.

1907g. Eine neue Copeognathe aus Süd-Tunis. *Ann. hist. — nat. Mus. hung.* 5 (2): 428-429, pl. ix.

1907h. *Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition nach dem Kilimandjaro, dem Meru und dem Ungebenden Massaisteppen Deutsch-Ostafrikas, 1905-1906, unter leitung von Prof. Dr. Yngve Sjöstedt. L. Copeognatha.* (Copeognatha: 15 (2): 29-30, figs. A-F, pl. 5).

1908a. Die Copeognathenfauna der Insel Formosa. *Zool. Anz.* 33: 759-779, 3 figs. Includes list of spp. from Formosa.

1908b. Copeognatha. *In* Schulze, L., Forschungsreise im westlichen und zentralen Südafrika. 3 Copeognatha: *Hexacyrtoma,* eine neue Copeognathengattung von Kapland. *Denkschr. med. -naturw. Ges. Jena* 13: 349-351, 2 figs., pl. XIX, fig. 1.

1908c. *Reise in Ostafrika in den Jahre 1903-1905 von Prof. Dr. Alfred Voeltzkow.* 1. *Die von Voeltzkow in Ostafrika und Madagascar gesammelten Copeognathen.* II. *Ueber die systematische Stellung von Thylax Hag. und zur Klassification der Lepidopsocinen. Wissenschaftliche Ergebnisse. Band 2, Systematische Arbeiten.* Stuttgart. (Copeognatha: pp. 245-252, 252-257, 3 figs., pl. 11).

1908d. Über die biogeographische Stellung der Crozet-Inseln. 14. Beitrag zur Kenntnis der antarktischen Fauna. *Zool. Anz.* 33: 751-753. (Corrodentia: p. 752). *Troctes divinatorius* listed and mentioned from Kerguelen and Crozet Is.

1908e. Über die Variabilität des Flügelgeäders der Copeognathen. *Zool. Anz.,* 33: 779-782, 12 figs. Especially *Psoquilla* spp.

1908f. Biologisch-faunistische Moor- und Dünen-Studien. Ein Beitrag zur Kenntnis biosynözischer Regionen in Westpreussen. 30. *Ber. Westpr. bot. -zool. Ver.* 30: 54-240, 6 figs., 1 map.

1909a. Neue Gattungen und Arten nordamerikanischer Copeognathen. *Boll. Lab. zool. Portici* 3: 329-339, 4 figs.

1909b. Diplacanthoda Bouvieri, nouveau genre de Copeognathes (Psocinae) de Madagascar. *Bull. Mus. Hist. nat., Paris* 15: 448-449, 1 fig.

1909c. Neue Gattungen und Arten von Copeognathen aus Transvaal sowie aus der Ohaus'schen Ausbeute aus Ecuador. *Stettin. ent. Ztg.* 70: 266-273, 3 figs. *Monocladellus* (from Ecuador), *Harpezoneura* (from Transvaal).

1909d. Copeognathen (Erste Reihe). (Biospeliogica XI). *Arch. Zool. exp. gén.* (5) 1: 533-539, pl. 18.

1909e. Zur Kenntnis frühjurassischer Copeognathen und Coniopterygiden und über das Schicksal der Archipsylliden. *Zool. Anz.* 34: 770-776, 3 figs. (Copeognatha: pp. 771-773, fig. 1).

1909f. Die Insekten der Antarktischen Gebiets. *Dtsch. Südpol. Exped.* 10 (II) 4: 361-528, 42 figs. (A-QQ), pls. XL-LXIII. (Copeognatha: pp. 406-407, 442, 467, 485, fig. CC). Species from Crozet, Kerguelen and St. Paul Is.

1909g. Die Klassification der Embiidinen nebst morphologischen und physiologischen Bemerkungen, besonders über das Spinen derselben. *Zool. Anz.* 35: 166-191. Grouping of Corrodentia discussed, pp. 171-172.

1910a. Eine Dekade neuer Copeognathengattungen. *S.B. Ges. naturf. Fr. Berl.* 1910 (2): 63-77, 10 figs. *Pelmatocoria, Steleops, Lichenomima, Phlotodes, Rhaptoneura, Euplocania, Labocoria, Colposeopsis, Trigonosceliscus.*

1910b. Neue aussereuropäische Copeognathen. *Zool. Anz.* 36: 161-169, 4 figs. South America and Canary Islands.

1910c. Die Copeognathen Norwegens. *Nyt. Mag. Naturv.* 48: 318-323. List.

1911a. *Archipsocus dextor* spec. nov. eine Gespinste anfertigende Copeognathe aus Ostafrika. *Zool. Anz.* 37: 142-144, 2 figs. Title reads "*dextor*", text reads "*textor.*"

1911b. Die fossilen Copeognathen und ihre Phylogenie. *Palaeontographica* 58: 279-360, figs. A-S, pls. XXI-XXVII (figs. 1-103). Phylogeny and classification of the order; key to fossil genera, systematic account of fossil species.

1912a. Über einige hervorragende neue Copeognathen-Gattungen. *Zool. Anz.* 39: 298-306, 2 figs. *Anopistoscenea, Pentathyrsus, Udamolepis, Thylacomorpha, Scoliopsyllopsis, Empheriella.*

1912b. Über die Gespinnste von *Archipsocus recens* Enderl. 1903 (mit biologischen Beobachtungen von Edward Jacobson). *Notes Leyden Mus.* 34: 157-160, pls. 4, 5.

1912c. Über einige orientalische Copeognathen des Leidener Museums. *Notes Leyden Mus.* 34: 161-162. 9 spp. and varieties listed.

1913. Beiträge zur Kenntnis der Copeognathen. I, II. I. Zur Kenntnis der Copeognathen Hawaii. II. Uber einige Copeognathen an Zitronenbaümen in Ostafrika. *Zool. Anz.* 41: 354-360. (I. pp. 354-358; II. pp. 358-360).

1914. Beiträge zur Kenntnis der Copeognathen. III. Ueber einige von Professor Silvestri in Westafrika gesammelte Copeognatha. *Boll. Lab. Zool. Portici* 8: 240-241, 2 figs. 4 spp. dealt with.

1917. Beiträge zur Kenntnis der Copeognatha. IV. Zur Kenntnis der Copeognathen des Kongogebietes. *Zool. Anz.* 49: 254-256, 3 figs.

1918. Beiträge zur Kenntnis der Copeognathen. *Psocus bastmannianus* n. sp. aus Finnland. *Zool. Jb. Abt. Syst.* 41: 487-488, pl. 8, 1 fig.

1919. Copeognatha. *Collections Zoologique du Baron Edm. de Selys-Longchamps* 3 (2): 1-55, 10 figs., 5 pls.

1920a. *In* Brohmer, P. *Fauna von Deutschland.* Heidelberg. (Copeognatha: pp. 135-139, 11 figs.)

1920b. Die Copeognathen der Hawaii-Inseln. *Zool. Jb. Abt. Syst.* 43: 449-460, pls. V, VI.

1922. A scaly-winged Psocid, new to science, discovered in Britain. *Ent. mon. Mag.* 58: 101-104. *Pteroxanium squamosum.* (A footnote in Enderlein 1923a. reads: "Beiträge VI findet sich in Entomologist's Monthly Magazine, 3 ser. Vol. 8, 1922, page 101").

1923a. Beiträge zur Kenntnis der Copeognathen. VII. Uber die Typen Blanchards chilenisches Copeognathen. *Zool. Anz.* 55: 245-248, 1 fig. (A footnote to Enderlein, G. 1926a., p. 191, mentions this paper as "Beiträge zur Kenntnis der Copeognathen VIIa").

1923b. Beiträge zur Kenntnis der Copeognathen. VII. Zwei neue Copeognathen aus dem Museum Paris. *Konowia* 2: 32-33. One sp. from Ecuador and one from Tunis. (A footnote to Enderlein, G. 1926a., p. 191, mentions this paper as "Beiträge zur Kenntnis der Copeognathen VIIb").

1924a. Beiträge zur Kenntnis der Copeognathen. VIII. Uber die Drüsenhaare der Larven und Nymphen einiger Gattungen der Copeognathen. *Tijdschr. Ent.* 67: 72-74.

1924b. Copeognathen. *In* Damph, A., Zur Kenntnis der estländischen Moorfauna (II). *S.B. Ges. naturf. Fr. Berl.* 31: 34-37.

1925. Beiträge zur Kenntnis der Copeognathen. IX. *Konowia* 4: 97-108, 1 fig. Genera erected: *Gigantopsocus, Colpostigma, Euclismia, Ptycta, Brachinodiscus, Mecampsis, Coryphosmila, Palaeoseopsis, Mepachycera.* New spp. and records from South America, Africa, Albania. (A footnote on p. 97 reads: "Es findet sich: VII. Uber die Typen Blanchards chilenischer Copeognathen. Zoolog. Anz. Bd. 55, 1923, pg. 245-248. VIII. (irrtümlich als VII. bezeichnet). Zwei neue Copeognathen aus dem Museum Paris. Konowia II. 1923, pg. 32-33.")

1926a. Beiträge zur Kenntnis der Copeognathen. X. Zwei neue chilenische Copeognathen. *Zool. Anz.* 46: 191-192.

1926b. Die Copeognathen fauna Javas. *Zool. Meded.* 9: 50-70. New spp. and list of 60 known spp. from Java.

1927. Copeognatha. *In* Brohmer, P., Ehrmann, P. and Ulmer, G. *Die Tierwelt Mitteleuropas.* Leipzig. (Psocoptera: 4 Lief, 2, vii, 16 pp. 38 figs.) Classification, keys, illustrations to European spp.

1929a. Ueber die Drüsenhaare der Larve der Fossilen *Trichadenotecnum trigonoscenea* (Endl. 1911). *Zool. Anz.* 83: 177-180, 3 figs.

1929b. Entomologica Canaria ii. *Zool. Anz.* 84: 221-234, 15 figs. (Copeognatha: pp. 223-225, fig. 2).

1931. The Percy Sladen Trust Expedition to the Indian Ocean in 1905 under the leadership of Mr. Stanley Gardiner, M. A. VIII. Die Copeognathenfauna der Seychellen. *Trans. Linn. Soc. Lond. (Zool.)* (2) 19: 207-240, 52 figs., pls. 14-16. List of spp. known from Seychelles, new spp. and records for area.

1932. Über die systematische Stellung der Copeognathengattung *Pseudopsocus* Kolbe 1882. *Zool. Anz.* 98:224-226, 1 fig.

1936. Schwedisch-chinesische wissenschaftliche Expedition nach den nordwestlichen Provincen Chinas. 30. Copeognatha. *Ark. Zool.* 27 (A) (16): 1-7, 5 figs. (separate dated 1934).

Enock, F.

1897. (Report of minutes of meeting of 5th May, 1897). *Proc. ent. Soc. Lond.* 1897: xviii. *Alaptus fusculus* Hal. in *Stenopsocus cruciatus* eggs exhibited.

Esaki, T.

1932. *Japan Insects Illustrations.* 2240 pp., 24 Pls., over 4000 unnumbered illustrations. Tokyo. (Psocids: pp. 1992-2001, with 20 figs., text in Japanese except for names and an index).

Esaki, T. **Hori,** H. and **Yosumatsu,** K.

1938. *Insectorum Japonicorum Illustratio Iconographica Coloribus ad Naturam Depicta.* Tokyo. 426 pp. illustr. (Psocoptera: pp. 33-34, pl. 14).

Esben-Petersen, P.

1910. *Illustrerede Haandbøger over den Danske Dyreverden. 8. Guldsmede, Døgnfluer, Slørvinger og Copeognather.* Copenhagen. 163 pp., 133 figs. (Copeognatha: pp. 134-163, figs. 120-133). Characters, keys, descriptions of Danish spp.

1933. Bidrag til en Fortegnelse over Bornholms Insektfauna. Orthoptera, Plecoptera, Ephemeroptera, Odonata, Copeognatha, Neuroptera, Mecoptera, Trichoptera. *Ent. Medd.* 18: 215-238. (Copeognatha: pp. 225-226).

Escherich, K.

1934. Zur bionomie der Copeognathen (Staublause). *Z. angew. Ent.* 2 (4): 636-638. Notes on habits of *Ectopsocus parvulus* Kolbe.

Essig, E.

1926. *Insects of Western North America.* New York. i-ix, 1035, 766 figs. (Corrodentia: pp. 123-125).
1940. A seed-infesting Psocid new to North America. *J. econ. Ent.* 33:946. *Lepinotus patruelis.*
1951. *College Entomology.* New York. (Corrodentia: pp. 184-192).
1958. *Insects and Mites of Western North America.* New York. i-xiv, 1050, pp. 766, figs.

Everts, J. G.

1925. Wetenschappelijke mededeelingen. *Tijdsch. Ent.* 68: II-IV. (Psocid p. IV). *Clothilla inquilina* in Coriander seed.

Fabian, S.

1943. See Dudich, E. et al, 1943.

Fabricius, J. C.

1775. *Systema Entomologiae, sistens Insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus.* Flensbergi et Lipsiae. 8, 16 and 832 pp.
1777. *Genera Insectorum eorumque characteres naturales secundum numerum, figuram, situm et proportionem omnium partium oris adjecta mantissa specierum nuper detectarum.* Chilonii, Bartsch. 310 pp.
1779. *Reise nach Norwegen mit Bermerkungen aus der Naturhistorie und Oekonomie. Hamburg.* 388 pp.
1781. *Species Insectorum exhibentes eorum differentias, specificas, synonyma auctorum, loca natalis, metamorphosin adiectis observationibus, descriptionibus.* Hamburgi et Kilonii. 2 vols. Vol. I, i-viii, 552 pp.; Vol. II, 494 pp.
1787. *Mantissa insectorum sistens eorum species nuper detectas adiectis characteribus, genericis, differentiis specificis, emendationibus, observationibus.* Hafniae. 2 Vols. Vol. I. i-xx, 348 pp.; Vol. II, 382 pp.
1793. *Entomologia systematica emendata et aucta, secundum classes, ordines, genera, species, adiectis, synonymis, locis, observationibus, descriptionibus.* Hafniae. 4 vols. (Psocids: Part II: 81-87).
1798. *Supplementum Entomologiae systematicae.* Hafniae.

Fabricius, O.

1780. *Fauna Groenlandica.* Hafniae et Lipsiae. 452 pp.

Farquharson, C. O.

1921. Five years' Observations (1914-1918) on the Bionomics of Southern Nigerian Insects, chiefly directed to the investigation of Lycaenid Life-histories and to the Relation of Lycaenidae, Diptera and other Insects to Ants. *Trans. R. ent. Soc. Lond.* 1921: 319-448. (Psocidae: pp. 418-420).

Fernald, R. T. and **Shepard,** H. H.

1955. *Applied entomology; an introductory textbook of insects in their relations to man.* New York. 5th. ed. 385 pp., illustr. (Corrodentia: p. 102).

Fernando, W.

1934. The early embryology of a viviparous Psocid. *Quart. J. micr. Sci.* 77 (1): 99-119, 19 figs. *Archipsocus fernandi.*

Ferriere, C.

1926. Notes sur les Chalcidiens de la Suisse. 2. Un parasite des oeufs de Psocides. *Schweiz. ent. Anz.* 5 (9): 1-3, 1 fig.

1930. On some egg parasites from Africa. *Bull. ent. Res.* 21 (1): 33-44, 6 figs. (Parasites of psocids: pp. 41, 42).

Finlayson, L. H.

1949. The life-history and anatomy of *Lepinotus patruelis* Pearman (Psocoptera-Atropidae). *Proc. zool. Soc. Lond.* 119 (2): 301-323, 12 figs.

Finlayson, L. R.

1933a. Some notes on the biology and Life-history of Psocids. *Sci. Agric.* 13: 404. *Liposcelis (Troctes) divinatorius* feeding on *Sitotroga* eggs.

1933b. Some notes on the biology and life-history of Psocids. *Rep. ent. Soc. Ont.* 63: 56-58. *Liposcelis divinatorius.*

Fischer, L. H.

1850. Beiträge zur Insecten-Fauna um Freiburg im Breisgau. (Zweite Fortsetz.). 17. *Jahresb. des Mannheim Ver. für Naturk.* 8: 60-70.

Fitch, E. A.

1880. Insects bred from *Cynips kollari* galls. *Entomologist* 13: 252-263. (Psocid: p. 263).

Fletcher, J. E.

1880. Occurrence of *Stenopsocus stigmaticus* Imhoff, near Worcester. *Ent. mon. Mag.* 16: 211.

Fourcroy, A. F.

1785. *Entomologia parisiensis.* Paris. 2 vols.

Franceschi, T.

1953. See Conci, C. 1953.

Franciscola, M. E.

1955. Fauna cavernicola del Savonese. *Ann. Mus. civico Stor. nat. Genoa* 67: 1-223, 6 figs.

Frauenfeld, G. von

1867. Zoologische Miscellen XI. *Ver. zool. -bot. Ges. Wien* 17: 445.

Freeman, J. A.

1945. Studies on the distribution of insects by aerial currents. The insect population of the air from ground level to 300 feet. *J. Anim. Ecol.* 14: 128-154, 3 graphs.

Freeman, P.

1938. Notes on the nesting habits of five species of solitary wasps (Hymenoptera, Sphecoidea). *Proc. R. ent. Soc. Lond.* (A) 13 (1/3): 1-6. (Psocoptera: pp. 1-2). Lists psocid prey of *Rhopalum clavipes.*

Frickhinger, H. W.

1929. Massenauftreten von Hőlzläusen. *Z. angew.* 15: 640.

Frisch, J. L.

1734. *Beschreibung von allerley Insecten in Teutschland, nebst nűtzlichen Anmerkungen und nőthigen Abbildungen von diesem kriechenden und fliegenden inländischen Gewűrme etc.* Berlin. 13 vols. (Psocids: Vol. 11, pp. 1-3, pl. 10, figs. 1-4).

Fristrup, B.
1942. *The Zoology of Iceland.* Copenhagen. (Copeognatha: in Vol. 3, part 41, 4 pp.) Lists 4 spp.

Frost, S. W.
1963. Winter insect light trapping at the Archbold Biological Station, Florida. *Flor. Ent.* 46 (1): 23-43. (Psocid: p. 30). *Psocus leidyi.*

Gadeau, H. de Kerville
1932. Mélanges Entomologiques. 5e Memoire. II. Catalogue embryonnaire des Neuroptères, Megaloptères, Rhaphidioptères, Mecoptères, Psocoptères, Plecoptères, Ephemeroptères et Trichoptères de la Normandie. *Bull. Soc. Amis Sci. nat. Rouen.* 66-67: 263-492, 2 pls. (Psocoptera: pp. 367-374).

Gahan, A. B.
1927. Description of a new species of Mymaridae parasitic in psocid eggs (Hymen.). *Pan-Pacific Ent.* 3: 180-181. Host not given.

Gahan, C. J.
1891. (Exhibit of *Atropos pulsatoria* at meeting of December 2nd, 1891). *Proc. ent. Soc. Lond.* 1891: xxxii-xxxiii. Reported being convinced that *pulsatoria* makes a ticking noise.

Gambles, R. M.
1932. The Psocoptera of Wicken Fen. *Nat. hist. Wicken Fen.* 6: 567-579, 4 figs.
1933. *Mesopsocus laticeps* (Kolbe) a psocid new to Britain. *Ent. mon. Mag.* 69: 224-226, 2 figs.
1935. Scottish Psocoptera. *Scot. Nat.* 231: 83-88.

Garcia del Cid, F.
1940. Insectos bibliófagos y sus enemigos en las bibliotecas de Cataluña. *VI. Congr. int. Ent. Madrid.* 1935, 1: 399-404, 2 figs., pl. xii. (See also 1940, *Rev. appl. Ent.* (A) 28: 555). *Liposcelis divinatorius.*

Gay, C.
1851. See Blanchard, E. 1851.

Geer, C. de
1778. Mémoires pour servir à l'histoire des Insectes. Stockholm. 7 vols. (Psocids: Vol. 7, pp. 41-48, 868, 869, pl. 4, figs. 1-4).

Geoffrey, E. L.
1799. *Histoire abrégée des insectes qui se trouvent aux environs de Paris, dans laquelle ces animaux sont rangés suivant un ordre methodique.* Paris. 2 vols. (Pou de bois: Vol. 2, p. 596).

George, V. P.
1952. On some arthropod microfossils from India. *Agra Univ. J. Res.* 1 (Sci.): 83-108, 79 figs. (Corrodentia: p. 85).

Ghani, M. A. and **Sweetman,** H. L.
1951. Ecological studies of the book-louse, *Liposcelis divinatorius* (Müll.) *Ecology* 32: 230-244, 6 figs.

Ghesquiere, J.
1947. *Ectopsocus* palmicoles du Congo belge. *Bull. Cerc. zool. Congolais* 18 (2): 40-41. Notes on habits and habitats.

Giard, A.

1895. Sur un exemplaire chilien de *Pterodela pedicularia* L. à nervation doublement anormale. *Act. Soc. sci. Chili* 5: 18-21. A translation of this is Giard, A. 1896.

1896. On a chilean example of *Pterodela pedicularia* L. with a doubly abnormal nervation. *Ann. Mag. nat. Hist.* (6) 17: 111-112, 4 figs. This is a translation of Giard, A. 1895.

Giese, B.

1964. Ergebnisse der Albanien — Expedition 1961 des Deutschen Entomologischen Institutes. 20 Beitrag. Psocoptera. *Beitr. zur Ent.* 14 (3/4): 245-249. (In German with summaries in Russian and English). List, distributions.

Girard, M.

1876. *Traité élémentaire d'Entomologie.* Paris. (Neuroptera: Vol. 2, pp. 260-570).

Girault, A. A.

1908. A monographic Catalogue of the Mymarid genus *Alaptus* Haliday, with descriptions of three new North American forms and of *Alaptus iceryae* Riley from type material. *Ann. ent. Soc. Amer.* 1: 179-195, 5 figs. (Psocid parasites: pp. 187-190, fig. 3).

1910. Synonymic and descriptive notes on the Chalcidoid family Mymaridae. *J.N.Y. ent Soc.* 18:233-259. (Psocid parasite p. 244).

1914. Hosts of Insect egg-parasites in Europe, Asia, Africa and Australasia, with a supplementary American list. *Z. wiss. Insektbiol.* 10: 87-91, 135-139, 175-178, 238-240. (Platyptera: p. 91). 2 spp. of *Alaptus* from *Stenopsocus cruciatus* (L.).

Glick, P. A.

1939. The distribution of insects, spiders and mites in the air. *Tech. Bull. U.S. Dep. Agric.* 673: 1-150, 13 figs, 5 pls.

Goss, R. J.

1952. The early embryology of the book-louse, *Liposcelis divergens* Badonnel (Psocoptera) (Liposcelidae). *J. Morph.* 91 (1): 135-167, 2 pls.

1953. The advanced embryology of the book louse *Liposcelis divergens* Badonnel (Psocoptera) (Liposcelidae). *J. Morph.* 92 (1): 157-205, 7 pls.

1954. Ovarian development and oögenesis in the book-louse, *Liposcelis divergens* Badonnel (Psocoptera, Liposcelidae). *Ann. ent. Soc. Amer.* 47 (1): 190-207, 2 pls.

Graff, M.

1840. Untrügliches Mittel gegen Bücherlaüse *(Termes pulsatorius). Stettin. ent. Ztg.* 1: 62.

Grasse, P.

1949. See Jeannel, R. 1949.

1951. See Badonnel, A. 1951.

Green, E. E.

1906. Supplementary note on the Scaly-winged Copeognatha. *Spolia zeylan.* 4: 123-125. Supplementary to Enderlein, G. 1906e.

1912. Note on a web-spinning Psocid. *Spolia zeylan.* 8: 71-72, 1 fig. 1 pl. Webbing of *Archipsocus* sp. and its being preyed upon by *Ploiariola polita* and "orange-red larvae of a series of *Thrips*."

Gregorio, A. de
1915. Sul *Troctes divinatorius* Müll. *Nat. sicil.* 22: 198-199, pl. 26.

Gressitt, J. L. and **Weber,** N. A.
1959. Bibliographic Introduction to Antarctic-Subantarctic Entomology. *Pacific Insects* 1 (4): 441-480, 1 fig. Previous records of psocids from area quoted.

Griffini, A.
1897. *Imenotteri, Neurotteri, Pseudoneurotteri, Orthotteri e Rincoti Italiani. Manuali Hoepli Entomologia.* IV, Milan. 687 pp., 243 figs. (Psocids: pp. 312-315, figs. 102-103).

Guermonprez, H. L. F.
1902. *Ectopsocus briggsi* McL., abundant at Bognor. *Ent. mon. Mag.* 38: 288.
1906. *Reuterella helvimacula* End., a new genus and species to the list of British Psocidae and the discovery of its hitherto unknown male. *Ent. mon. Mag.* 42: 57-59, pl. I.

Gurney, A. B.
1939. Nomenclatural notes on Corrodentia, with descriptions of two new species of *Archipsocus. J. Wash. Acad. Sci.* 29 (11): 501-515, 15 figs. Use of *Trogium, Atropos, Troctes, Lachesilla, Clothilla, Liposcelis* and ordinal names discussed.
1943. A synopsis of the Psocids of the tribe Psyllipsocini, including the description of an unusual new genus from Arizona. (Corrodentia, Empheriidae, Empheriinae). *Ann. ent. Soc. Amer.* 36 (2): 195-220, 6 pls.
1949. Distributional and synonymic notes on Psocids common to Europe and North America, with remarks on the distribution of Holarctic insects (Corrodentia). *J. Wash. Acad. Sci.* 39 (2): 56-65.
1950. Psocids likely to be encountered by Pest Control Operators. Pest Control Technology, Entomological Section (National Pest Control Association). (Corrodentia: pp. 131-163, figs. 61-63).
1962. Psocoptera. *Encycl. Brit.* 18: 667.

Hagen, H.
1849. Uebersicht der neueren Literatur betreffend die Neuropteren Linn. *Stettin. ent. Ztg.* 10: 55-61. (Psocidae: pp. 56-58).
1851. Neuropterologische Notizen. *Stettin. ent. Ztg.* 12: 164-166. (*Lepinotus*: p. 166).
1854. Ueber die Neuropteren der Bernsteinfauna. *Verh. zool. -bot. Ges. Wien* 4: 221-232. (Psocids: pp. 225-226).
1856. Die im Bernstein befindlichen Neuropteren der Vorwelt. *In* Berendt, G. *Die im Bernstein befindlichen organischen Reste der Vorwelt etc.* Berlin. (Psociden: pp. 57-64, Taf. V, figs. 9-11; Taf. VII, fig. 21; Taf VIII, figs. 6-10).
1858a. Russlands Neuropteren. *Stettin. ent. Ztg.* 19: 110-134. (Psocoptera: p. 134).
1858b. Synopsis Neuroptera Ceylons. I Theil. *Verh. zool. -bot. Ges. Wien* 8: 471-489. (Psocidae: pp. 473-475).
1859. Synopsis der Neuroptera Ceylons. II Theil. *Verh. zool. -bot. Ges. Wien* 9: 199-212. (Psocina: pp. 199-205).
1861a. Synopsis of the British Psocidae. *Entomologist's Annual* 1861: 17-32.
1861b. Synopsis of the Neuroptera of North America; with a list of South American species. *Smithson. misc. Coll.* 4 (1): xx, 358 pp. (Psocids: pp. 7-14, 302).
1863. Observations on certain North American Neuroptera. *Proc. ent. Soc. Philad.* 2: 167-182. (Psocids: pp. 167-168). Translated and with notes by B. D. Walsh. See also Walsh, B. D. 1863.

1865a. The Neuroptera of Madeira. *Ent. mon. Mag.* 2: 8-11, 25-28, 59-62, 75-81. (Psocids: pp. 9-11).
1865b. Synopsis of the Psocina without ocelli. *Ent. mon. Mag.* 2: 121-124.
1865c. On some aberrant genera of Psocina. *Ent. mon. Mag.* 2: 148-152. Continued as Hagen, H. 1866a.
1865d. Beiträge zur Kenntnis der Phryganiden. V. Neuropteren um Zürich nach Bremi's Mitteilungen. *Stettin. ent. Ztg.* 26: 228-232. (Psocids: pp. 229-231). 10 spp. listed.
1866a. On some aberrant genera of Psocina. *Ent. mon. Mag.* 2: 170-172. Continuation of Hagen, H. 1865c.
1866b. Psocinorum et Embidinorum Synopsis synonymica. *Verh. zool. -bot. Ges. Wien* 16: 201-222.
1866c. Beiträge zur Kenntnis und Synonymie der Psociden. *Stettin. ent Ztg.* 27: 188-196, 233-244.
1873. Report on the Pseudoneuroptera and Neuroptera of North America in the collection of the late T. H. Harris. *Proc. Boston. Soc. nat. Hist.* 15: 263-301. (Corrodentia: pp. 277-281). 9 spp. listed.
1876. Pseudoneuroptera. *In* Kidder, J. H. Contributions to the Natural History of Kerguelen Island made in connection with the United States transit of Venus Expedition, 1874-75. II. *Bull. U.S. nat. Mus.* 1 (3): 1-122. (Psocoptera: pp. 52-57).
1881-2. Some Psocina of the United States. *Psyche, Camb. Mass.* 3: 195-196, 207-210, 219-223, (1881); 402 (1882).
1882. Beiträge zur Monographie der Psociden. Ueber Psociden im Bernstein. *Stettin. ent. Ztg.* 43: 265-276, 217-237, 276-300, 524-526, pls. I, II. The pagination given is the sequence intended; an editorial note on p. 265 explains how the error in sequence occurred. The section commencing on p. 217 is headed "Ueber Psociden im Bernstein." This paper is continued as Hagen, H. 1883b.
1883a. The Tarsal and antennal Characters of Psocidae. *Ent. mon. Mag.* 19: 12-13. *(Psyche, Camb., Mass.* 4: 52).
1883b. Beiträge zur Monographie der Psociden. Familie Atropina. *Stettin. ent. Ztg.* 44: 285-332. A continuation of Hagen, H. 1882. "Fortsetzung des Artikels von Jahrgang 1882 Seite 300."
1886. Kurze Bemerküngen ueber das Flügelgeäder der Insekten. *Wien. ent. Ztg.* 5: 311-312.

Haller, G.

1874. Ueber einige bis jetzt weniger bekannte Tonapparate der Insekten. *Zool. Gart., Lpz.* 15: 106-110, 223-226. (Psocid: pp. 108, 226). *Troctes pulsatorius.*

Hamard, G.

1959a. See Badonnel, A. and Hamard, G. 1959.
1959b. Contribution à l'étude des Psocoptères (II). Aperçu systematique sur la faune de Psocoptera de la région de Rennes (Bretagne, France) comprenant notamment deux especes nouvelles pour la faune française, *Elipsocus nuptialis* Roesler, *Elipsocus pallidus* Jentsch. *Vie et Milieu. Paris* 10: 412-416, 1 fig.

Hamard-Rose, G.

1962. Sur le polymorphisme alaire chez le Psoque *Psyllipsocus ramburi* S.L. (Insecte, Psocoptère) et ses relations avec l'effet de groupe. *C.R. Acad. Sci. Paris* 254 (7): 1329-1330.

Handlirsch, A.

1904. Zur Systematik der Hexapoden. *Zool. Anz.* 27 (23/24): 733-759.
1905. Phylogenetisches über Insekten. *Zool. Anz.* 28: 664-670, 4 figs.
1906-8. *Die Fossilen Insekten und die Phylogenie der rezenten Formen.* Leipzig. i-ix, 1430 pp., pls. I-LI. (Copeognatha: pp. 27, 702-704, 1098, 1182, 1220, 1221, 1238, 1290).

1910. Zur Kenntnis "fruhjurassischer Copeognathen und Coniopterygiden" und über das Schicksal der Archipsylliden. *Zool. Anz.* 35: 233-240, 6 figs.

1925. Corrodentia. *In* Schröder, C. *Handbuch der Entomologie.* Jena. (Corrodentia: Vol. 3, pp. 507-515).

1930. Ordnung Corrodentia, *In* Kükenthal, W. and Krumbach, T. *Handbuch der Zoologie.* Berlin and Leipzig. Vol. 4, i-xiv, 892 pp. 945 figs. (Corrodentia: Vol. 4, pp. 863-876, figs. 909-927).

Handschin, E.

1961. Insekten in eingelagertem Holz. *Verh. naturf. Ges. Basel.* 72 (1): 88-99. (Psocoptera: pp. 89-99). 27 spp. listed.

Hanow, M. C.

1737. *Erlaüerte Merkwürdigkeiten der Natur.* Danzig. i-vi, 426 pp.

1753. *Seltenheiten der Natur und Oekonomie, nebst deren Kurzen Beschriebung u. Erorterung etc.* Leipzig. 3 vols.

Hardy, J.

1848. On the manner in which the Female of *Psocus quadripunctatus* constructs a web to protect her eggs. *Newman's Zoologist* 6: 2221-2222.

Hargreaves, E.

1915. See Corbett, G. H. and Hargreaves, E. 1915.

Harper-Gray, R. A.

1917. Notes on a plague of psocids in a factory. *Ann. appl. Biol.* 4: 47-49. *Caecilius pedicularius.*

Harris, T. W.

1869. Entomological Correspondence of Thaddeus William Harris, M. D. Edited by S. H. Scudder *Occ. Pap. Boston Soc. nat. Hist.* 1: i-xlvii, 375 pp., 46 figs., 4 pls. Psocids on pp. 327-333 in "Descriptions of insects selected from the manuscripts of Dr. Harris" pp. 325-336; 8 psocids are described most or all of which are now known to be synonymous with described species, several so indicated by S. H. Scudder.

Harrison, J. W. H.

1916a. A November week at Grange-over-Sands. V. Psocoptera collected by Richard S. Bagnall, F.L.S. *Lancs. Nat.* 9: 107-109.

1916b. Notes on Psocoptera. *Entomologist* 49: 134-135. A few British spp. mentioned.

1923a. *Leptella fusciceps* and how to rear it and other minute Psocidae. *Vasculum* 10: 15-16.

1923b. Notes and Records. *Vasculum* 9: 61-63. (Psocoptera: p. 62). Records for *Leptella fusciceps* and *Reuterella helvimacula.*

Hart, T. H.

1880. Extreme abundance of *Caecilius pedicularius. Ent. mon. Mag.* 17: 141-142. In cornfields in Kent, England. A query by Hart as to identification is answered by R. McLachlan.

Hartmann, F.

1951. Die Psociden (Copeognathen) der Umgebung von Basel. *Verh. naturf. Ges. Basel* 62: 91-180, 19 figs.

Hartmeyer, R.

1907. See Enderlein, G. 1907b.

Haskell, P. T.
1961. *Insect Sounds.* London: 1-190, figs. 1-95. (Psocoptera, pp. 29, 50, 59, 109 & 153).

Hawkins, J.
1939. Corrodentia as pests of ground feed. *J. econ. Ent.* 32: 467. *Troctes divinatorius* in America.

Heller, W.
1928. En for faunan ny psocid, *Lepinotus formicarius* Hag. *Medd. Soc. Fauna Fl. fenn.* 4: 30.

Henriksen, K. L.
1929. Copeognatha. *Zoology of the Faroes.* Copenhagen. (Copeognatha: Vol. 2, Part 1, xxxvi, 1 page). *Atropos pulsatoria.*
1939. A revised index of the insects of Grønland containing a supplement to the insect list of Kai L. Henriksen and Will. Lundbeck. *Medd. Grønland* 119 (10): 1-112.

Henriksen, K. L. and **Lundbeck,** W.
1917. Landarthropoder (Insects et Arachnidae). *Medd. Grønland* 22: 481-821. (Psocids: p. 707).

Herford, G. V. B.
1930. See Richards, O. W. and Herford, G. V. B. 1930.

Heyden, G. H.
1850. Zwei neue deutsche Neuropteren-Gattungen. *Stettin. ent. Ztg.* 11: 83-85. (Psocina: pp. 84-85).

Heymons, R.
1909. Ein neuer *Troctes* als Schädling in Buchweizengrütze. *Dtsch. ent. Z.* 1909: 452-455, 3 figs.

Hickin, N. E. and **Robins,** E. L. D.
1945. Psocids infesting puppies. *Ent. mon. Mag.* 81: 214. *Trogium pulsatorium.*

Hickman, V. V.
1934. A contribution to the study of Tasmanian Copeognatha. *Pap. roy. Soc. Tasm.* 1933: 77-89, 6 figs.

Hicks, E. A.
1959. *Check list and Bibliography of the occurrence of insects in birds' nests.* Ames. 681 pp. (Corrodentia: pp. 158-164). Bibliographical references and named bird hosts.

Hilton, W. A.
1937. Nervous system and sense organs. LXVIII. Corrodentia. *J. Ent. Zool.* 29 (4): 97-98, 1 fig.

Hincks, W. D.
1960. A new British species of the genus *Alaptus* Haliday (Hym., Mymaridae). *Entomologist* 93: 170-172, 3 figs. Reared from Psocid eggs.

Hobby, B. M.
1944. See Broadhead, E. and Hobby, B. M. 1944.
1945. See Broadhead, E. and Hobby, B. M. 1945.

Hodges, F. A.

1958. See Daly, A. W., Blomquist, V. H. and Hodges, F. A. 1958.

Hodson, A. C.

1960. Rearing of book lice for biological studies. *Proc. ent. Soc. Amer.* 15: 66.

Holzapfel, M.

1932. Die Gewächshausfauna des Berner Botanischen Gartens. *Rev. suisse Zool.* 39: 325-374. (Psocids: pp. 342-343). *Trichopsocus hirtellus* (McL.) and *Ectopsocus briggsi* (McL.) listed as found in greenhouse.

1936. Zur Kenntnis der schweizerischen Copeognathen-fauna. *Rev. suisse Zool.* 43: 335-357.

Hoppe, T. C.

1745. *Anmerkungen über die sogenannten Todtenuhr-Insecten (Psocus).* Gera. 16 pp.

Hori, H.

1938. See Esaki, T., Hori, H. and Yosumatsu, K. 1938.

Houlbert, C.

1903. *Les insectes ennemis des livres. Leurs moeurs, moyen de les détruire.* Paris.

Houltuin, M.

1768. *Natuurlijke historie of uitvoerige beschrijving der Dieren. Planten en Mineraalen, volgens het samenstel van den Heer Linnaeus.* Amsterdam. 3 vols. (Neuroptera: Vol. 1, pp. 1-104).

Howard, O.

1902. Minutes of meeting of May 8th, 1904. *Proc. ent. Soc. Wash.* 5: 103. Notes Peyerimhoff, P. de, 1901 and says the swallowing of air by moulting psocids was described in Hubbard, H. G. 1885, p. 195 in case of *Psocus citricola.*

Hubbard, H. G.

1880. Two days collecting in the Mammoth Cave, with contributions to a study of its fauna. *Amer. Ent.* 3: 34-40, 79-84.

1885. *Insects affecting the orange.* Washington. i-x, 220 pp., 14 pls. (Psocoptera: pp. 193-196).

Huber, P.

1843. Mémoire pour servir a l'histoire des Psoques. *Mém. Soc. Phys. Genève* 10: 35.

Hudson, G. V.

1892. *An elementary Manual of New Zealand Entomology.* London. 122 pp., frontis., 20 Pls. (Psocidae p. 107, pl. xvi, figs., 2, 2a). *Psocus zelandicus* figured, pl. XVI, figs., 2, 2a.

Huie, L. H.

1916. Observations on the hatching of *Stenopsocus cruciatus. Scot. Nat.* 1916: 61-65, fig. 5, pl. I.

Hurd, P. D., **Smith,** R. F. and **Durham,** J. W.

1962. The fossiliferous amber of Chiapas, Mexico. *Cienca (Mex.)* 21: 107-118, 1 pl. Mentions Amphientomidae, Liposcelidae and Myopsocidae as occurring.

Husson, R.
1936. Contribution à l'étude de la Faune des cavités souterraines artificielles. *Ann. Sci. nat.* 19: 5-30. (Psocids: p. 13).

Hutton, F. W.
1899. The Neuroptera of New Zealand. *Trans. Proc. N.Z. Inst.* 31: 208-249. (Psocids: p. 211).

Iharos, A.
1943. See Dudich, E. et al. 1943.

Illiger, J. C. W.
1798. *Kugelann Verzeichniss der Käfer Preussens, ausgearbeitet von Illiger, mit einer vorrede von Hellwig und angehängten Versuch einer natürlichen ordnung und Gattungsfolge der Insecten.* Halle. i-xli, 510 pp.

Imhoff, L. and **Labram,** J. D.
1846. *Insecten der Schweiz.* Basel.

Imms, A. D.
1957. *A General Textbook of Entomology.* (9th Ed. revised by Richards, O. W. and Davies, R. G.) London. i-x, 886 pp., 609 figs. (Psocoptera: pp. 252, 399-405, figs. 318-321).

Iwata, K.
1939. Habits of *Rhinonitela domestica* Williams, a minute booklouse-hunter in Formosa. *Mushi* 12 (1): 13-16.

Jacobson, E.
1912. See Enderlein, G. 1912b.
1924. Zur Kenntnis der Biologie javanischer Copeognathen. *Tijdschr. Ent.* 67: suppl. 65-71. Spinning; *Psocus flavistigma, Lichenomima sumatrana.*

Jacobson, G. G. and **Bianchi,** W. L.
1904. *Die Orthopteren und Pseudoneuropteren des Russischen Reiches und der angrenzenden Lander (Russisch).* Petersburg. (Psocoptera: pp. 482-496, 48 figs).

Jeannel, R.
1926. Faune cavernicole de la France, avec une étude des conditions d'existence dans la domaine souterraine. *Encycl. ent. (A)* 7: 1-334, 74 figs. (Psocids: pp. 207-208). *Prionoglaris stygia* End. and *Nymphopsocus troglodytes* End. recorded.
1949. *In* Grassé, P. *Traité de Zoologie.* Paris. 17 vols. (Fossil Psocoptera: Vol. 9, pp. 78-79, fig. 84).

Jentsch, S.
1936. Ovoviviparie bei einer einheimischen Copeognathenart (*Hyperetes guestfalicus*). *Zool. Anz.* 116: 287-289, 2 figs.
1938a. Beiträge zur Kenntnis der Überordnung Psocoidea. 3. Die Gattung *Amphigerontia* (Copeognatha). *Zool. Anz.* 122: 87-94, 5 figs.
1938b. Beiträge zur Kenntnis der Überordnung Psocoidea. Zur Copeognathenfauna Nordwesfalens. *Abh. westfäl. Prov. Mus. naturk.* 9 (4): 3-42, 55 figs.
1939a. Beiträge zur Kenntnis der Überordnung Psocoidea. 7. Vergleichend entwicklungbiologische und ökologische Untersuchungen an einheimischen Psocopteren unter besonderer Berücksichtigung der Art *Hyperetes guestfalicus* Kolbe 1880. *Zool. Jb. Abt. Syst.* 73: 1-46, 9 figs.

1939b. Beiträge zur Kenntnis der Überordnung Psocoidea. 8. Die Gattung *Ectopsocus* (Psocoptera). *Zool. Jb. Abt. Syst.* 73: 111-128, 18 figs.

1939c. Beiträge zur Kenntnis der Überordnung Psocoidea. 9. Zur Kenntnis der Psocopterenfauna in Nordwest deutschland. *Verh. Ver. naturw. Unterh. (Heimatforsch) Hamb.* 27: 114-121. 40 spp. listed.

1940. Beiträge zur Kenntnis der Überordnung Psocoidea. 10. Zur Morphologie des Gehirns und Lichtsinnesorgane der Psocopteren. *Zool. Jb. Abt. Anat.* 66: 403-436, 28 figs. Morphology of brain and sense organs for perceiving light studied in *Hyperetes guestfalicus, Liposcelis divinatorius, Psyllipsocus ramburii* (and its var. *destructor), Ectopsocus meridionalis, Mesopsocus immunis* and *Amphigerontia contaminata.*

Karl, O.

1937. Ein Beitrag zur Kenntnis der Insektenfauna Ostpommerns. Netzflügler, Geradflügler und Holzlaüse. *Dohrniana* 16: 56-60.

Karlshoven, L. G. E.

1950. *De plagen van de cultuurgewassen in Indonesie. Deel. I.* The Hague. 512 pp., illustr. (Psocoptera: p. 145).

Karny, H. H.

1921. Zur Systematik der Orthopteroiden Insekten. *Treubia* 1: 207-210.

1924. On a new Empheriid from Uganda (Copeognatha). *Ann. Mag. nat. Hist.* (9) 14 (25): 245-246, 4 figs. *Psylloneura ugandana.*

1925. On the Copeognatha from Mt. Murud and Mt. Dulit, Sarawak. *Sarawak Mus. J.* 3 (8): 63-74, 1 pl.

1926a. On some tropical Copeognatha, especially from Fiji Islands. *Bull. ent. Res.* 16: 285-290, 5 figs. Fiji, Nigeria, Tahiti.

1926b. *In* Dammerman, K. W. The fauna of Durian and the Rhio-Luigga Archipelago. *Treubia* 8: 281-326, 1 pl. (Copeognatha: p. 314). 4 spp. mentioned, generic identification only.

1930. Zur Systematik der Orthopteroiden Insekten. II. *Treubia* 12: 431-461. Keys to tribes, recent and fossil; index to genera; higher classification.

1932. Psocoptera. *Insects of Samoa* 7 (4): 117-129, 8 figs.

Karny, R.

1926. Uma nova especie de *Epipsocus* do Brasil. *Publ. Mus. nae. Rio de J.* 8: 3-7.

Katiyar, K.

1953. See Roonwal, M. L. et al. 1953.

Kawall, J. H.

1864. Verzeichnis der Orthopteren und Neuropteren Kurlands. *Korr. Blatt. naturf. Ver. Riga* 14: 155-168.

Keler, S. von

1953. *Staublaüse.* Leipzig, Neue Brehm-Bűcherei. Heft 110., 48 pp., 20 figs.

Kellogg, V. L.

1896. New Mallophaga. II. From land birds together with an account of the mallophagous mouthparts. *Proc. Calif. Acad. Sci.* (2) 4: 431-548, pls. 60-73. (Psocidae: pp. 463-468, pl. 64, figs. 5-11). (Summary in *J.R. micr. Soc.* 1897: 122).

1902. Are the Mallophaga degenerate Psocids? *Psyche, Camb., Mass.* 9: 339-343.

Kemner, N. A.

1933. Om insekter och insektador i herbarier. *Bot. Notiser* 1-3: 439-455, 7 figs. (Psocid: pp. 447-448). *Troctes divinatorius.* See also *Rev. appl. Ent. (A)* 22: 243.

Kemp, S. V.

1903. Psocidia at Missenden, Bucks. *Entomologist* 36:49. 7 spp. listed from Missenden, England.

Kemper, H.

1935. Die Pelz- und Textilschädlinge und ihre Bekämpfung. *Kleintier u. Pelzt.* 11 (4/5): 123-187.

1950. *Die Haus- und Gesundheitschädlinge und ihre Bekämpfung. Ein Lehr- und Nachschlaagebuch für den Schädlings bekämfer.* Berlin. 344 pp., 242 figs.

Kidder, J. H.

1876. See Hagen, H. 1876.

Kimmins, D. E.

1929. Notes on British Psocoptera in 1928. *Entomologist* 62: 100.

1940. *Peripsocus subfasciatus* (Ramb.) (Psocopt.) under stones. *Ent. mon. Mag.* 76: 248.

1941a. The Types of some genera of Plecoptera and Psocoptera. *Entomologist* 74: 87. Type species designated for: *Cerastipsocus* Kolbe, *Holoneura* Tetens, *Myopsocus* Hagen, *Peripsocus* Hagen, *Ptilopsocus* Enderlein.

1941b. Notes on British Psocoptera. I. *Elipsocus hyalinus* (Steph.) and its allies. *Ann. Mag. nat. Hist.* (11) 7: 520-530, 5 figs. *E. mclachlani* sp.n. *(E. hyalinus* McL. not Stephens) additional description, distribution and discussion of identity and synonymy of *E. hyalinus* and *E. westwoodi.*

1941c. *Lepidilla kelloggi* Rib. (Psocoptera) in Westmorland. *J. Soc. Brit. Ent.* 2 (3): 98.

1941d. *Lepidilla kelloggi* and *Caecilius piceus* Rib. var. *brevipennis* End. in Surrey (Psocoptera). *J. Soc. Brit. Ent.* 2 (3): 98-99.

1941e. A list of the Psocoptera of Kent, Surrey and Sussex, with a revised list of the British species. *J. Soc. Brit. Ent.* 2 (3): 93-98. Lists 68 spp. for Britain.

1943. Some records of Lake District Psocoptera. *J. Soc. Brit. Ent.* 2 (4): 157-158.

King, J. J. F. X.

1882. Notes on the Neuroptera of Strathglass, Invernesshire. *Ent. mon. Mag.* 19: 8-12. (Psocidae: p. 11). 12 spp. listed.

1883. Occurrence of *Caecilius piceus* Kolbe in Britain. *Ent. mon. Mag.* 20: 142. A note by R. McLachlan is attached on identity of specimens and distribution of species.

1885a. *Elipsocus cyanops* Rost. in Scotland and *Caecilius piceus* Kolbe in England. *Proc. nat. Hist. Soc. Glasgow* (2) 1: 19.

1885b. Notes on the Neuroptera of Argyllshire. *Trans. nat. Hist. Soc. Glasgow* (2) 1: 163-169.

1886a. Notes on the Neuroptera of Rothiemurchus and Kingussie. *Trans. nat. Hist. Soc. Glasgow* 1: 354-365. (Psocoptera: pp. 356-357).

1886b. *Caecilius piceus* Kolbe and *C. burmeisteri* Brauer in Scotland. *Ent. mon. Mag.* 23: 39. Records two spp. in Scotland.

1888. A contribution towards a catalogue of the Neuropterous fauna of Ireland. *Trans. nat. Hist. Soc. Glasgow* 2: 259-292.

1889. (Reprint of King, J. J. F. X. 1888). *Nat. Hist. Soc. Glasgow.* 1-38. (Psocoptera: pp. 7-10).

1899. Pseudo-Neuroptera, Planipennia and Trichoptera collected at Rannock in June, 1898. *Ent. mon. Mag.* 35: 80-83. (Psocidae: p. 81). 2 spp. listed.

1900. Neuroptera collected in the upper portion of Strathglass in 1899. *Ent. mon. Mag.* 36: 181-185. (Psocidae: pp. 181-182). 12 spp. listed.

1910. List of the Clyde Copeognatha or Psocidae. *Glasg. Nat.* 2: 34-36.

King, J. J. F. X. and **Halbert,** J. N.

1910. A list of the Neuroptera of Ireland. *Min. Proc. R. Irish Acad.* 28 (B2): 29-112. (Psocoptera: pp. 64-71).

Kirkpatrick, T. W.

1927. Biological control of insect pests with particular reference to the control of the common coffee mealybug in Kenya Colony. *Proc. S. and E. Afr. Agric. Conf.* 1926: 174-196. 9 spp. of Psocoptera, commonest is *Ectopsocus briggsi* McL. reported as predaceous on the coffee mealybug.

Klapalek, F.

1898. Zpráva o Neuropterách a Pseudoneuropterách sbíraných v Bosně a Hercegovine *Věstn. čes. Akad.* 2: 1-22.

1900a. Přispěvek ke znalostí fauny Neuropteroid Ceskomoravské krabatiny. *Věstn. čes. Akad.* 10: 1-6.

1900b. Přisprěvek ke znalostí Neuropteroid z Krajiny a Korutan. *Rozpr. čes. Akad.* 9: 1-12.

1903a. Zpráva o výzkumu českých Neuropteroid v.r. 1902. *Věstn. čes. Akad.* 12: 257-264.

1903b. Ein Beitrag zur Kenntnis die Neuropteroiden von Ober-Steiermark. *S.B. bőhn. Ges. Wiss.* 1903 (IX): 1-5. (Corrodentia: p. 4). 8 spp. listed.

1904. Zpráva o výsledcich cesty do Transylvanských Alp a Vysokých Tater. *Věstn. čes. Akad.* 13: 1-12.

1906. See Strobl, G. and Klapáiek, F. 1906.

Klier, E.

1956. Zur Konstruktionsmorphologie des männlichen Geschlechtsapparates der Psocopteren. *Zool. Jb. Abt. Anat.* 75: 207-286, 75 figs. Description of male reproductive system of several spp.; comparison, copulation.

Klippel, R.

1957. Őkologische Untersuchungen an Arthropoden in Kellern Hamburger Wohnhäuser. *Ent. Mitt.* 9: 15-16. 4 spp. listed.

Kloet, G. S. and **Hincks,** W. D.

1945. A check list of the British Insects. Stockport lix, 483 pp.

Knowlton, G. F. and **Stains,** G. S.

1941. Psocids infesting chinchillas in Utah. *J. econ. Ent.* 34: 118-119, 1 fig. *Liposcelis* sp.

Kolbe, H. J.

1880a. Das Flűgelgeäder der Psociden und seine systematische Bedeutung. *Stettin. ent. Ztg.* 41: 179-186, 1 pl.

1880b. Monographie der deutschen Psociden mit besonderer Berucksichtigung der Fauna West-falens. *Jber. westf. ProvVer. Wiss. Kunst* 8: 73-142, pls. i-iv.

1880c. Bemerkungen zu Dr. Jacob Spångberg's Psocina Sueciae et Fenniae. *Stettin. ent. Ztg.* 41: 176-178. (Ref. Spångberg, J. 1878).

1880d. Ueber die Genera *Atropos* Leach und *Troctes* Burm. *Ent. Nachr.* 6: 84.
1881a. Ueber eine introducirte Psociden species. (*Caecilius hirtellus* McLach.) *Stettin. ent. Ztg.* 42: 77-79.
1881b. Psocidologische Berichtigungen. *Ent. Nachr.* 7: 254-256. (Refers especially to Rostock, M. 1881).
1881c. Differenzen in dem Vorkommen einiger Psociden-species. *Stettin. ent. Ztg.* 42: 236-237.
1882a. Das phylogenetische Alter der europäischen Psocidengruppen. *Jber. westf. ProvVer. Wiss. Kunst* 10: 18-27.
1882b. Neue Psociden der palaärktischen Region. *Ent. Nachr.* 8: 207-212.
1883a. Ueber das Genus *Myopsocus* und dessen species. *Ent. Nachr.* 9: 141-146.
1883b. Ueber die Racen des *Psocus taprobanes* Hagen, in Ostindien. *Ent. Nachr.* 9: 152-154.
1883c. Ueber *Mesopsocus aphidioides* Schrank und *Elipsocus laticeps* Kolbe. *Berl. ent. Z.* 27: 235-238. *Mesopsocus* and *Elipsocus* characterized.
1883d. Neue Psociden des Kőnigl. zoologischen Museums zu Berlin. *Stettin. ent. Ztg.* 44: 65-87. *Cerastis, Syngonosoma* and *Blaste.*
1883e. Neue Beiträge zur Kenntniss der Psociden der Bernstein-Fauna. *Stettin. ent. Ztg.* 44: 186-191.
1884a. Der Entwicklungsgang der Psociden im Individuum und in der Zeit. *Berl. ent. Z.* 28: 35-38.
1884b. Zur Frage űber die Quintessenz des Characters im habitus einer zoologischen Species. *Berl. ent. Z.* 28: 39-42. *Stenopsocus* spp.
1884c. Das Tracheensystem des Kopfes der Bűcherlaus *(Atropos pulsatorius). Berl. ent. Z.* 28: 177-178, 1 fig.
1884d. Ueber *Hyperetes* in biologischer und systematische Beziehung, nebst einer Studie űber die phylogenetische Stellung dieser Gattung. *Ent. Nachr.* 10: 84-87.
1884e. Beitrag zur Kenntniss der Psocidenfauna der Berliner Umgegend. *Ent. Nachr.* 10: 287-290.
1884f. Ueber die von Herrn Ludy in Ober-Bayern, Kärnthen und im Littorale gesammelten Psociden. *Berl. ent. Z.* 28: 380-382.
1885a. Zur kenntniss der Psociden-Fauna Madagaskars. *Berl. ent. Z.* 29: 183-192, pl. IVB.
1885b. Ein Wort zur systematische Stellung der Pscociden. *Berl. ent. Z.* 29: 266.
1885c. Die Borneo-Rasse des *Psocus taprobanes* Hg. *Ent. Nachr.* 11: 328-330.
1885d. Zwei merkwűrdige und unbekannte Nymphen von Psociden. *Jber. westf. ProvVer. Wiss. Kunst* 14: 59-61, pl. III, figs. 4, 5.
1888a. *Troctes silvarum* sp.n. eine im Freien lebende Verwandte der Staublaus. *Ent. Nachr.* 14: 234-236.
1888b. Psocidae. *In* Rostock, M. Neuroptera germanica. Die Netzflűgler Deutschlands, mit Berűcksichtigung auch einiger ausserdeutschen Arten nach der analytischen Methode unter Mitwirkung von H. Kolbe bearbeitit. *Jber. Ver. Naturk. Zwickau* 1887: 1-198, pls. i-x.
1893. *Einfuhrung in die Kenntnis der Insekten.* Berlin, i-xii, 709 pp., 324 figs. Completed in 1893, but had been appearing in parts for some time, according to Zoological Record for 1893.

Konigsmann, E.
1960. Zur Phylogenie der Parametabola. *Beitr. zur. Ent.* 10 (7/8): 705-744.

Koppen, F. T.
1879. Die Schädlichen Insekten Russlands. *Beitr. Kennt. russ. Reichs* (2) 3: i-vi, 526 pp. 1 pl. (Psocids: pp. 43, 89).

Krombein, K. V.
1951. See Muesebeck, C. F. W., Krombein, K. V. and Townes, H. K. 1951.

Krumbach, T.
1930. See Handlirsch, A. 1930.

Kruseman, G.

1943a. Nieuwe Psociden voor Nederland. *Tijdschr. Ent.* 86: XXIV-XXV.

1943b. 3e Mededeeling over Nederlandsche Psocoptera. *Tijdschr. Ent.* 86: LII-LIII. 8 spp. listed, a total of 45 spp. known from Holland.

1944. Voorlopige Naamlijst van Nederlandsche Psocoptera, benevens van die, welke in het aangrenzende gebied gevonder zijn. (4e Mededeeling over Psocoptera). *Tijdschr. Ent.* 86: 94-97. Lists 52 spp. from Holland and lists spp. occurring in adjacent areas.

1948. 4de Korte Faunistische Mededeeling. Overgedruck mit het Verslag van de Honderdeerste Zomervergardering der Nederlandsche Entomologische Vereeniging, 22 June, 1946. *Tijdschr. Ent.* 89:XLV-XLVI. (Psocoptera: p. XLV). List, alterations to list in Kruseman, G. 1944.

Kukenthal, W.

1930. See Handlirsch, A. 1930.

Kunstler, J. and **Chaine,** J.

1902. *Kiefferia musae* (nov. gen., nov. spec.) Cecidomide nouvelle. *Trav. Lab. Arachon* 6: 113-118.

1903a. Du dimorphisme chez les Cecidomyes. *P.V. Soc. sci. phys. nat. Bordeaux* 1903: 13-14.

1903b. *Kiefferia musae* (n.g. n.sp.) Cecidomyide nouvelle. *Bull. Soc. sci. Arcachon* 1902: 1-6, 3 figs.

Kuwayama, S.

1924. See Okamoto, H. and Kuwayama, S. 1924.

1961. Corrodentia of Thailand. *Nature and Life in S.E. Asia* 1: 203-205, 1 fig.

Labram, J. D.

1846. See Imhoff, L., and Labram, J. D. 1846.

Lacroix, J.

1913. Quelques anomalies chez les Psoques. *Insecta* 3 (29): 162-167, 7 figs. Wing venation anomalies.

1915a. Description d'un Psocide nouveau. *Bull. Soc. ent. Fr.* 1915: 179-182, 2 figs. *Psocus lapidetectus.*

1915b. Psocides nouveaux (Nevr.) *Bull. Soc. ent. Fr.* 1915: 192-195, 4 figs. *Psocus allaudi, Fabrella convexa.*

1919. Description d'un Psocide nouveau, de France. *Bull. Soc. ent. Fr.* 1919: 80-81, 1 fig.

Laing, F.

1924. A psocid new to the British list. *Entomologist* 57: 238. *Nymphopsocus destructor.*

1925. On a new genus and species of Psocoptera from British Guiana. *Entomologist* 58: 289-290, figs. A-L. *Semnopsocus globifer.*

1932. A note on our British domestic Psocids. *Ent. mon. Mag.* 68: 68-69. Several spp. mentioned with some description and life history included.

Lameere, A.

1900. *Manuel de la Faune de Belgique. Tome II. Insectes inférieurs.* Bruxelles. 858 pp., 721 figs.

1935. Précis de Zoologie. *Rec. Inst. zool. Torley-Rousseau* 4: 1-260 (1934); 261-468 (1935), 480 figs. (Insects: pp. 57-468, Psocoptera: pp. 352-359).

Landt, J.

1800. *Beskrivelse over Faerøerne.* Kjøbenhavn. Psocid mentioned.

Latreille, P. A.

1794. Découverte de nids de Termes, et Psocus décrits. *Bull. Soc. philom. Paris* 1: 84-85.
1796. *Précis des Charactères génériques des Insectes disposés dans un Ordre naturel.* Paris. (Psocoptera: p. 99).
1799. Le genre Psocus. *In* Coquebert, A. J. 1799.
1805. *Histoire naturelle des Crustaces et Insectes.* Paris, 1802-1805, 14 vols. (Psocoptera: Vol. 13, p. 71).
1810. *Considérations générales sur l'Ordre naturel des Animaux composant les Classes des Crustaces, des Arachnides et des Insectes.* Paris. (Psocoptera: pp. 277, 435).

Laurence, B. R.

1951. The prey of some tree trunk frequenting Empididae and Dolichopodidae (Dipt.). *Ent. mon. Mag.* 87: 166-169. Empididae and Dolichopodidae feeding on *Cerobasis guestfalicus.*
1952. The prey of some Empididae and Dolichopodidae (Dipt.). *Ent. mon. Mag.* 88: 156-157. *Empis livida* carrying *Loensia fasciata.*

Leach, W.

1815. *The Edinburgh Encyclopaedia.* Edinburgh. (Psocoptera: Vol. 9, p. 139).

Leonard, M. D.

1928. See Chapman, P. J. and Nadler, A. M. 1928.

LeRuth, R.

1939. La biologie du domaine souterrain et la faune cavernicole de la Belgique. *Mém. Mus. Hist. nat. Belg.* 87: 1-506, illustr. (Copeognatha: pp. 202-204). 3 spp. dealt with.

Lestage, J. H.

1935. Note sur un Psoque. Hote multiple des dunes coxydoises (*Lachesilla pedicularia* L.). *Bull. (Ann.) Soc. ent. Belg.* 75: 344-345.

Lindroth, C. H.

1931. Die Insektenfauna Islands (Iceland) und ihre probleme. *Zool. Bidrag. Upsala* 13: 105-589, 50 figs. (Psocids: pp. 140-142). 3 spp. listed from Iceland, with notes and references.

Linne, C. von

1746. *Fauna Suecica sistens animalia Sueciae regni* etc. Stockholm.
1758. *Systema Naturae per regna tria naturae secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis,* Ed. decima reformata. Holmiae. 2 vols.
1761. *Fauna Suecica sistens animalia Sueciae regni* etc. Stockholm.
1775. *Systema naturae. XII Edition.* (*P.L.S. Müller*). Nűrnberg. Band 2, Theil 5.

Linsley, E. G.

1942. Insect fool caches as reservoirs and original sources of some stored products pests. *J. econ. Ent.* 35: 434-439. (Psocids: p. 437). *Troctes divinatorius* in bees' nests.
1944. Natural sources, habitats and reservoirs of insects associated with stored products. *Hilgardia* 16 (4): 187-224.

Lintner, J. A.

1885. *New York State Entomologist Second Annual Report. Second Report of Injurious and other insects in the State of New York.* New York i-xiv, 221 pp. (cf. *Wien. ent. Ztg.* 5: 204).

Loding, H. P.

1935. A psocid, *Psoquilla slossonae* (Banks). *Bull. Brooklyn ent. Soc.* 30: 112. *P. slossonae* found in great numbers on walls of bungalow in Alabama.

Loens, H.

1889a. Zur Kenntniss der Psocidenfauna Pommerns. *Stettin. ent. Ztg.* 50: 329-333. List.
1889b. Psocidologisches. *Jber. westf. ProvVer. Wiss. Kunst* 17: 75-78. 34 spp. listed.
1890a. Geflügelte *Pyrrhocoris apterus* und ähnliche Erscheinungen bei Psociden. *Ent. Nachr.* 16: 10-12.
1890b. Albinismus bei *Psocus sexpunctatus* L. *Ent. Nachr.* 16: 49-50.
1890c. Zur Psocidenfauna Westfalens. *Stettin. ent. Ztg.* 51: 5-8.
1905. Zwei unbeschriebene deutsche Psociden. *Jber. westf. ProvVer. Wiss. Kunst.* 33: 45.

Ludwig, F.

1908. Zur biologie des *Stenopsocus stigmaticus* des blattlausähnlichen Spinnflüglers. *Stettin. ent. Ztg.* 69: 195-198, 1 fig.

Lundblad, O.

1925. Über das Vorkommen von Trichobothrien bei Neuropteren und Corrodentien. *Ent. Tidskr.* 46: 96-101, 7 figs.

Majewski, E.

1882. *Insecta Neuroptera Polonia.* Warsaw. 42 pp. (in Polish).
1885. *Neuroptera Polonia.* Warsaw. viii, 40 pp. (in Polish).

Marcu, O.

1938. Die Flechtlinge (Copeognatha) der Bukowina. *C.R. Acad. Sci. Roum.* 2 (5): 496-498. List.

Mardzhanyan, K. S.

1963. See Svadzhyan, P. K., Vishnyakova, V. N. and Mardzhanyan, K. S. 1963.

Marikovskii, P. I.

1957. *Mesopsocus hiemalis* sp.n. (Psocoptera) and some peculiarities of its biology. *Zool. Zh.* 36 (7): 1026-1030, 4 figs. (In Russian with English summary).

Martin, R.

1892. Les Psocides du department de l'Indre. *Rev. Ent., Caen* 11: 285-288.
1931. *Histoire naturelle de la France.* Paris.

Martorell, L. F.

1945. A survey of the forest insects of Puerto Rico. Pts. I, II. *J. Agric. Univ. P.R.* 29 (3): 69-354; 29 (4): 355-608. illustr. (Corrodentia: scattered refs in Pt. I; Pt. II, p. 367).

Martynov, A.

1926. Jurassic fossil insects from Turkestan. 6. Homoptera and Psocoptera. *Bull. Acad. Sci. U.R.S.S.* 1926: 1349-1366, 9 figs.
1928. Permian fossil insects of North-East Europe. *Trav. Mus. géol. U.R.S.S.* 4: 1-118, pls. I-XIX.

Martynova, O. M.

1961. See Becker-Migdisova, E. E. 1961.

Maschke, K.
1935. See Pax, F. and Maschke, K. 1935.

Mather, R. N.
1953. See Roonwal, M. L. et al. 1953.

Mathur, R. K.
1953. See Roonwal, M. L. et al. 1953.

Matsumoto, K.
1941. A list of Japanese Psocoptera. *Kontyû* 15 (3): 127-131.

Matsumura, S.
1911. Erster Beitrag zur Insekten-Fauna Sachalin. *J. Coll. Agric. Sapporo* 4 (1): 1-145, 2 pls. Records *Caecilius oyamae* from South Saghalien, first psocopteran from the island.

McClure, H. E.
1936. Psocid habits. *Ent. News* 47: 113-118, 143-146.

McCook, H. C.
1884. On a web-spinning Neuropterous Insect. *Proc. Acad. nat. Sci. Philad.* 1883: 278-279.

McDaniel, E. I.
1934. Cockroaches, silver-fish and booklice. *Bull. Mich. agric. Exp. Sta.* 101:10-11. Mention of *Liposcelis divinatorius*.

McKeown, K. C.
1922. Booklice on citrus trees. *Aust. nat.* 5 (4): 57-58. General remarks on an unnamed sp.
1942a. Australian Insects XV. Booklice, Lice and Thrips. *Aust. Mus. Mag.* 7: 382-387, illustr. (Psocids: pp. 382-383, 1 illustr.). General remarks.
1942b. *Australian Insects*. Sydney: 1-304, illustr. (Copeognatha, p. 74 & fig.)

McLachlan, R.
1866a. Untitled note. *Proc. ent. Soc. Lond.* 5: XLV. Venational variation discussed.
1866b. (Notice in minutes). *Proc. ent. Soc. Lond.* 5: lxxiv. Ticking noise.
1866c. New genera and species of Psocidae. *Trans. ent. Soc. Lond.* (3) 5: 345-352. Species from South America, New Guinea, Australia, Assam, China, Malacca, East Indies, Mauritius. A postscript on p. 352 reassigns several species described in *Psocus* to genera erected by Hagen, 1866b.
1867a. Untitled note. *Ent. mon. Mag.* 4: 20. A remark following paper by Blackwall doubting that ticking sounds are made by *Atropos*. See Blackwall, J. 1867.
1867b. A monograph of the British Psocidae. *Ent. mon. Mag.* 3: 177-181, 194-197, 226-231, 241-245, 270-276, pl. II.
1867c. Atropos. *Hardwicke's Science Gossip.* 1867: 51-52. Nomenclature; sound production.
1869. Description of a new species of Psocidae *(Caecilius atricornis)* inhabiting Britain. *Ent. mon. Mag.* 5: 196.
1870. *A catalogue of British Neuroptera.* London.
1872a. An addition to the list of British Psocidae *(Stenopsocus stigmaticus* Im. and Lab.). *Ent. mon. Mag.* 9: 63-64. Also *Caecilius dalii.*
1872b. Description of a new genus and five new species of exotic Psocidae. *Ent. mon. Mag.* 9: 74-78, 1 fig. Ceylon, Sula, Northern India.

1872c. Instructions for the collection and preservation of neuropterous insects. *Ent. mon. Mag.* 9: 90-104, 168-176, 225-232. (Psocidae: pp. 173-174).
1877. Description d'un Psocide nouveau de la Belgique, *C.R. Seances Soc. ent. Belgique* 20: liv-lv.
1879. A second British locality for *Stenopsocus stigmaticus*. *Ent. mon. Mag.* 16: 94-95. Distribution records.
1880a. *Elipsocus cyanops* Rostock a species new to Britain. *Ent. mon. Mag.* 17: 21.
1880b. *Elipsocus cyanops* Rostock. *Ent. mon. Mag.* 17: 71. Further British specimens.
1880c. Notes on entomology of Portugal II. Pseudoneuroptera (in part) and Neuroptera-Planipennia. *Ent. mon. Mag.* 17: 103-108. (Psocidae: pp. 103-104). 3 spp. listed, *Myopsocus eatoni* described.
1880d. Untitled note. *Ent. mon. Mag.* 17: 141-142. An editorial note to Hart, T. H. 1880. Psocids feed on mildew, dust and debris.
1880e. Trichoptera and Neuroptera of the Upper Engadine in August. *Ent. mon. Mag.* 17: 217-222. (Psocidae: p. 221). *Elipsocus unipunctatus* mentioned.
1881a. (Editorial comment, under Spångberg, J. 1880 paper). *Zool. Rec.* 1880: 211. Says *Stenopsocus nervosus* St. is var. of *cruciatus* L.
1881b. Abundance of *Clothilla picea* Motsch. *Ent. mon. Mag.* 17: 185-186.
1883a. Neuroptera of the Hawaiian Islands. Part I. Pseudo-Neuroptera. *Ann. mag. Nat. Hist.* (5) 12: 226-240. (Psocidae: p. 228). 2 spp. listed.
1883b. Neuroptera of the Hawaiian Islands. Part II. Planipennia, with General Summary. *Ann. Mag. nat. Hist.* (5) 12: 298-303. (Psocidae: in summary, p. 302). 2 spp. listed.
1883c. The Neuroptera of Madeira and the Canary Islands. *J. Linn. Soc. (Zool.)* 16: 149-183. (Psocids: pp. 155, 174-175). 6 spp. listed.
1883d. Remarks on certain Psocidae, chiefly British. *Ent. mon. Mag.* 19: 181-185, 3 figs.
1884a. Recherches Neuropterologiques dans les Vosges. *Rev. Ent., Caen* 3: 9.
1884b. *Caecilius atricornis* McLach. near Chertsey. *Ent. mon. Mag.* 21: 113-114. Mentions also *Stenopsocus stigmaticus*.
1886a. *Kolbia quisquiliarum* Bertkau, a genus and species of Psocidae new to Britain. *Ent. mon. Mag.* 23: 38-39.
1886b. Un excursion Neuropterologique dans la Foret-Noire. *Rev. Ent., Caen* 5: 126-136. (Psocids: pp. 132-134).
1887. *Caecilius dalii* abundant in Somersetshire. *Ent. mon. Mag.* 24: 136.
1890a. Two species of Psocidae new to Britain. *Ent. mon. Mag.* 26: 269-270.
1890b. Notes concerning *Psocus quadrimaculatus* Latr. of which *Ps. subnebulosus* Steph., is a synonym. *Ent. mon. Mag.* 26: 287-289.
1894a. Some additions to the Neuropterous fauna of New Zealand, with notes on certain described species. *Ent. mon. Mag.* 30: 238-243, 270-272. (Psocidae: p. 270). Type location of *Myospsocus novae-zealandiae* Kolbe.
1894b. Two species of Psocidae new to Britain. *Ent. mon. Mag.* 30: 243-244.
1898a. A few Psocidae from the Eastern Pyrenees. *Ent. mon. Mag.* 34: 153-154. 6 spp. listed.
1898b. *Hyperetes guestfalicus* Kolbe, a genus and species of apterous Psocidae new to Britain. *Ent. mon. Mag.* 34: 247-248.
1899a. Trichoptera, Planipennia and Pseudoneuroptera collected in the district of the Lac de Joux (Swiss Jura) in 1898. *Ent. mon. Mag.* 35: 60-65. (Psocidae: p. 64). 5 spp. listed.
1899b. *Psocus major* Loens at Merton (Norfolk). *Ent. mon. Mag.* 35: 210.
1899c. *Psocus major* (Kolbe) Loens in Co. Wexford. *Ent. mon. Mag.* 35: 234.
1899d. *Ectopsocus briggsi*, a new genus and species of Psocidae found in England. *Ent. mon. Mag.* 35: 277-278, illustr.

1900a. Concerning *Teratopsocus maculipennis* Reuter with note on the brachypterous condition in females of Psocidae. *Ent. mon. Mag.* 36: 6-7.
1900b. A striking instance of neural variation in a Psocid. *Ent. mon. Mag.* 36: 14. *Caecilius obsoletus.*
1900c. Psocidae on the wing: a query. *Ent. mon. Mag.* 36: 43.
1900d. *Hyperetes guestfalicus* Kolbe at Dover. *Ent. mon. Mag.* 36: 88.
1900e. *Bertkauia prisca* Kolbe, a genus and species of Psocidae new to Britain. *Ent. mon. Mag.* 36: 220-221.
1900f. Two species of *Psocus* allied to *Ps. bifasciatus* Latr. likely to occur in Britain. *Ent. mon Mag.* 36: 242. *Psocus intermedius* Tetens; *Ps. contrarius* Reuter.
1902. Psocidae from the district of the Lac de Joux (Swiss Jura). *Ent. mon. Mag.* 38: 176-177. 10 spp. mentioned.
1903a. Psocidae at Margate in 1903. *Ent. mon. Mag.* 39: 285-286. 9 spp. listed.
1903b. What is the native country of *Ectopsocus briggsi* McLach? *Ent. mon. Mag.* 39: 296-297. May have come to England from Australia or Rhodesia.

Medem, F.
1951. Biologische Beobachtungen an Psocopteren. *Zool. Jb. Abt. Syst.* 79: 591-613, 2 figs.

Melander, A. L.
1954. See Brues, C. T., Melander, A. L. and Carpenter, F. M. 1954.

Menon, R.
1938a. Coxal interlocking in the Lepidopsocidae and its probable taxonomic value. *Curr. Sci.* 7: 66-67, 1 fig.
1938b. Two new species of Pachytroctidae (Copeognatha) with a note on the family. *Proc. Indian Acad. Sci.* 8 (4): 280-287, figs. A, B, 1, 2.
1941. Studies on Indian Copeognatha (Psocoptera) I. Introduction, general morphology and classification. *Indian. J. Ent.* 3: 13-23, 10 figs.
1942. Studies on Indian Copeognatha (Psocoptera) II. Nanopsocetae and Psocatropetae. *Indian J. Ent.* 4: 23-42, 38 figs.

Menzel, R.
1922. Spinneweb-achtige nesten van hautluizen op thee boomen. *Thee* 3 (2): 54-55, pl. 9.

Meunier, F.
1906. *Perientomum mortuum* Hagen (Meun.). Archiptère Psocidae du Copal fossile de Zanzibar. *Naturaliste* 28: 58-60.

Meyer-Dur, R.
1874. Die Neuropterenfauna der Schweiz bis auf heutige Erfahrung. *Mitt. schweiz. ent. Ges.* 4: 281-352 (1874), 344-364 (1875). (Psocidae: pp. 284 et seq.).

Michaelsen, W.
1907. See Enderlein, G. 1907b.

Mockford, E. L.
1950. The Psocoptera of Indiana. *Proc. Ind. Acad. Sci.* 60: 192-204. List.
1951. On two North American Philotarsids (Psocoptera). *Psyche Camb., Mass.* 58 (3): 102-107, 2 pls.
1953a. Additional notes on Indiana Psocoptera. *Proc. Ind. Acad. Sci.* 62: 198-199.

1953b. Three new species of *Archipsocus* from Florida (Psocoptera: Archipsocidae). *Florida Ent.* 36 (3): 113-124, 30 figs.

1955a. Studies on the Reuterelline Psocids (Psocoptera). *Proc. ent. Soc. Wash.* 57: 97-108, 17 figs.

1955b. Notes on some Eastern North American Psocids with descriptions of two new species. *Amer. Midl. Nat.* 53 (2): 436-441, 2 pls.

1957a. A new species of *Archipsocus* from Florida (Psocoptera: Archipsocidae). *Florida Ent.* 40 (1): 33-34, 6 figs.

1957b. Some Psocoptera from Tikal, Guatemala. *Ent. News* 68 (8): 197-205, 21 figs.

1957c. Life history studies on some Florida insects of the genus *Archipsocus* (Psocoptera). *Bull. Florida Mus.* 1 (5): 253-274, 1 fig.

1959. The *Ectopsocus briggsi* complex in the Americas (Psocoptera, Peripsocidae). *Proc. ent. Soc. Wash.* 61: 260:266, 8 figs. 1 map.

1961a. An annotated list of the Psocoptera of the Flint-Chattahoochee-Apalachicola Region of Georgia, Florida and Alabama. *Florida Ent.* 44: 129-140. 38 spp. listed.

1961b. The rediscovery and probable phylogenetic position of *Psilopsocus* (Psocoptera). *Psyche Camb., Mass.* 68: 38-44, 1 fig. pl. 5. A n. sp. from the Philippines.

1962. Notes on the distribution and life history of *Archipsocus frater* Mockford (Psocoptera: Archipsocidae). *Florida Ent.* 45 (3): 149-151, 2 figs.

1963. The species of Embidopsocinae of the United States (Psocoptera: Liposcelidae). *Ann. ent. Soc. Amer.* 56 (1): 25-37, 68 figs.

Mockford, E. L. and **Gurney,** A. B.

1956. A review of the Psocids, or book-lice and bark-lice, of Texas (Psocoptera). *J. Wash. Acad. Sci.* 46: 353-368, 53 figs, 1 map.

Monterosso, B.

1952a. *Liposcelis divinatorius* (Műller) II. Partenogenesi constante e completa. *Boll. Accad. gioenia, ser.* IV, 2 (2): 151-167. (In Italian with French, German and English summaries).

1952b. *Liposcelis divinatorius* (Műller) III. Identificazione sistematica di una forma che vive in Sicilia (*L. bostrychophilus* Bad.) *Boll. Accad. gioenia, ser.* IV, 2 (3): 168-179. (In Italian with French, German and English summaries).

1953. *Liposcelis (=Troctes) divinatorius* (Müll.) I. Osservazioni morfologiche e biologiche. *Atti Accad. gioenia* (6) 8: 191-218. (In Italian with English, French and German summaries).

Morley, C.

1899. *Caecilius atricornis* McLach. near Ipswich. *Ent. mon. Mag.* 35: 272-273.

Morstatt, H.

1912. Ueber das Vorkommen von Gespinsten bei Psociden. *Z. wiss. InsektBiol.* 8 (4): 142-147. *Archipsocus textor,* predators.

Morton, K. J.

1902. Trichoptera, Planipennia and Pseudoneuroptera collected in North Wales in July, 1901. *Ent. mon. Mag.* 38: 34-36. (Psocids: p. 36). 5 spp. recorded.

Motschulsky, V. von

1851. Enumérations des nouvelles espèces des Coléoptères rapportés par M. Victor Motschulsky de son dernier voyage. *Bull. Soc. imp. Nat. Moscou* 24 (2): 479-511, 1 fig. (Psocoptera: pp. 510-511). *Paradoxides psocoides.*

1852. *Etudes entomologiques.* Helsingfors. (Psocids: in Etudes entomologiques 1852, 1 Juillet. pp. 19, 20). *Liposcelis museorum, L. brunneus* and *Paradoxenus.*

Muesebeck, C. F. W.

1956. A braconid parasite of a psocid. *Proc. ent. Soc. Wash.* 58: 148-149, 1 fig. Host: *Anomopsocus amabilis.*

Muesebeck, C. F. W., **Krombein,** K. V. and **Townes,** H. K.

1951. Hymenoptera of North America north of Mexico, Synoptic catalog. *Dep. Mon. U.S. Dep. Agric.* 2, 1420 pp., 1 map. (cf. Peck, O. 1951).

Muhlen, M. von zur

1882. Die Psociden Liv- Est- und Kurlands. *S.B. gelehrt. estn. Ges.* 6: 328-334. 25 spp. listed.

Muller, O. F.

1764. *Fauna insectorum Friedrichsdalina sive methodica descriptio insectorum agri Fridrichdalensis, cum characteribus etc. . . .* Hafniae. i-xxiv, 96 pp.

1776. *Zoologiae Danicae prodromus seu animalium Daniae et Norvegiae indigenarum charateres, nomina, et synonyma imprimis popularium.* Hafniae. 8vo. 32 and 282 pp.

Mumford, E. P.

1942. Records of Corrodentia from the Marquesas Is. *Ann. Mag. nat. Hist.* (11) 9: 831-838.

Nadler, A. M.

1928. See Chapman, P. J. and Nadler, A. M. 1928.

Navas, L.

1906a. Catálogo descriptivo de los Insectos Neurópteros de las Islas Canarias. *Rev. Acad. Madr.* 4 (1): 687-708. (Psocids: pp. 703-704). 5 spp. listed.

1906b. Notas zoológicas. XII. Novedades zoológicas de Aragon. *Bol. Soc. aragon. Cienc. nat.* 12 (9): 199-213, pls. 3, 4, 1 fig. (Psocid: p. 205). *Psocus quadrimaculatus* mentioned.

1907a. Notas Zoológicas XIII. Insectos nuevos ó recientemente descriptos de la peninsula ibérica. *Bol. Soc. aragon. Cienc. nat.* 6: 194-200, 3 figs. (Psocids: pp. 195-196, fig. 2). *Actenotarsus hispanicus.*

1907b. Neuróptero nuevos de Montserrat. *Rev. Montser.* 1907: 1-2, 1 fig.

1908. Neurópteros nuevos. *Mem. R. Acad. Barcelona ser. 3,* 6 (25): 401-423, 29 figs. (Psocids: pp. 410-411, figs. 12, 13). Canary Is.

1909a. Entomologie. *Rev. Quest Sci.* 1909: 1-12. (Psocoptera: p. 5). Mentions that 85 spp. are known from United States of America.

1909b. Neurópteros nuevos de la fauna ibérica. *Act. Mem. Prim. Congr. Natur. Espan. ser. 5,* 1: 143-158, pl. 13, figs. 1-10. (Psocids: pp. 155-158, pl. 13).

1909c. Nouvelles chasses de Neuropteres en Belgique. *R. mens. Soc. ent. Namur* 3: 55-56. (Psocid: p. 55).

1910a. Mis excursiones entomológicas durante el verano de 1909. *Bull. Inst. Catalaña* 2: 1-27. (Psocids: pp. 15, 23).

1910b. Notas entomológicas, 2e serie. 2. Excursiones por Cataluña y Mallorca. *Boll. Soc. aragon. Cienc. nat.* 10: 240-248. (Psocids: pp. 244-245). 10 spp. listed.

1911. Notas entomológicas. 3. Excursiones por los alrededores de Granada. *Bol. Soc. aragon. Cienc. nat.* 10 (12): 204-211, pl. 4. (Psocoptera: pp. 210-211, pl. 4).

1912a. Insectos Neurópteros nuevos o poco conocidos. *Mem. R. Acad. Barcelona ser. 3,* 10 (9): 135-202, 29 figs. (Psocids: p. 202). 2 spp. mentioned, neither new.
1912b. Neurópteros nuevos de America. *Broteria ser zool.* 10: 194-202, figs. 1-7. (Psocids: pp. 196-198, figs. 5, 6).
1913a. Notas entomológicas. *Bol. Soc. aragon. Cienc. nat.* 12: 75-91, pl. v. (Psocid: p. 87, pl. v).
1913b. Sócidos (Ins. Neur.) de España, nuevos. *Rev. Acad. Madr.* 12: 329-335, 5 figs. 5 new spp., 2 new genera.
1913c. Notas entomológicas. 5. Cuatro pequeñas coleciones de Neurópteros. *Bol. Soc. aragon Cienc. nat.* 12 (5): 77-89, 2 figs. (Psocidae: pp. 87-88, fig. 2). List and description of *Mesopsocus poecilopterus.*
1913d. Mis excursiones por el extranjero en el Verano de 1912. *Mem. R. Acad. Barcelona* 10 (24): 479-514, 17 figs. (Psocids: pp. 480, 488, 510). Records only, no new spp. described.
1914a. Supplement aux Nevroptères de Belgique. Quelques Nevroptères recuellis en août (19-31) de 1923. *Rev. Soc. ent. Namur.* 4 and 5: 1-7. (Psocidae: p. 6-7). List.
1914b. Notas entomológicas. 11. Neuropteros del Monacayo (Zaragoza). *Bol. Soc. aragon. Cienc. nat.* 13: 207-218. (Psocid: pp. 215-216).
1914c. Insectos neurópteros fósiles nuevos. *As. Esp. Progr. Cienc. Congr. de Madrid* 5: 35-38, 2 figs. 2 spp. described.
1914d. Notas entomológicas 7. Excursión anual de la Sociedad Aragonesa de Ciencias Naturales a Ortigosa y Valvanera (Logroño). *Bol. Soc. aragon. Cienc. nat.* 13: 22-37. (Psocids: p. 35). List.
1914e. Notas entomológicas. 10. Neurópteros de Mallorca. *Bol. Soc. aragon. Cienc. nat.* 13: 185-192. (Psocids: p. 190).
1914f. Notas entomológicas. 8. Neurópteros de los alrededores de Madrid. *Bol. Soc. aragon. Cienc. nat.* 13: 38-41. (Psocids: p. 41).
1914g. Notas entomológicas. 9. Algunos Neurópteros de Manresa. *Bol. Soc. aragon. Cienc. nat.* 13: 174-176. (Psocid: p. 176).
1915a. Notas entomológicas. 2a serie, 11. Excursiones por Cataluña. Julio de 1914. *Bol. Soc. aragon. Cienc. nat.* 14: 27-81, 7 figs., pls. ii, fig. 3. (Psocoptera: pp. 29, 30, 35, 39, 43-45, 48, 52, 57, 69, 70, 74, 76, 80).
1915b. Some Neuroptera from the United States. *Bull. Brooklyn ent. Soc.* 10 (3): 50-54, 2 figs. (Psocidae: p. 54). 5 spp. listed.
1915c. Neurópteros nuevos o poco conocidos (quinta serie). *Mem. R. Acad. Barcelona* 11 (27): 455-480, figs. 1-10, pl. 11. (Psocids: pp. 479-480, fig. 10).
1916a. Neuroptera nova africana. Ser. VII. *Mem. Accad. Nuovi Lincei ser 2,* 2: 51-58, figs. 29-34. (Psocoptera: pp. 57-58, figs. 33, 34). Canary Is., 2 spp.
1916b. Neurópteros nuevos de España (Segunda serie). *Rev. Acad. Madr.* 14: 593-601, figs. 3-5. (Psocids: pp. 598-600, figs. 3, 4).
1916c. Excursiones al Valle de Arán (Lérida), 17-28 Julio 1915. *Bol. Soc. aragon. Cienc. nat.* 15: 179-194. (Psocoptera: pp. 190-191). List.
1917a. Neurópteros nuevos o poco conocidos (Octavo serie). *Mem. R. Acad. Barcelona* 13 (7): 155-178, 14 figs. (Psocids: pp. 172-173, fig. 11).
1917b. Neurópteros nuevos o poco conocidos (Novena serie). *Mem. R. Acad. Barcelona* 13 (26): 393-406, 6 figs. (Psocids: pp. 402-403). *Caecilius burmeisteri.*
1917c. Comunicaciones entomológicas. 2. Excursiones entomológicas por Aragon y Navaria. *Rev. Acad. Cienc. Zaragoza* 2: 81-91. (Psocoptera: p. 88). List.
1917d. Insecta nova. *Mem. Accad. Nuovi Lincei ser. 2,* 3: 1-22, 9 figs. (Psocoptera: p. 20, fig. 9). 1 sp., Canary Is.
1917e. Notas entomológicas. 2e serie. 14. Neurópteros de Andorra. *Bol. Soc. aragon. Cienc. nat.* 16: 36-46. (Psocoptera: p. 43). List.

1917f. Excursiones entomológicas por el Norte de la Provincia de Lérida. 8-24 Julio, 1917. *Bull. Inst. Cataluña* 1917: 36-49. (Psocoptera: pp. 43-44). List.
1918a. Excursiones entomológicas al nort de la provincia de Lleida. *Bull. Inst. Catalana Hist. nat.* 1918: 150-158. (Psocids: pp. 156, 158).
1918b. Algunos insectos Neurópteros de la Argentina. *Physis, B. Aires* 3: 186-196, 4 figs. (Psocid: p. 196).
1918c. Algunos insectos Neurópteros de la Argentina. Serie 2a. *Physis, B. Aires* 4: 80-89, figs. 5-10. (Psocids: pp. 88-89, figs. 9, 10).
1918d. Neurópteros nuevos o poco conocidos. 10 ser. *Mem. R. Acad. Barcelona* 14: 339-366, 20 figs. (Psocids: p. 361, fig. 16).
1918e. Excursiones entomológicas por Cataluña durante el verano de 1918. *Mem. R. Acad. Barcelona* 15: 181-214, 9 figs. (Psocids: p. 204). List.
1919a. Mis excursiones científicas del verano de 1919. *Mem. R. Acad. Barcelona* 17: 143-169, 4 figs. (Psocids: pp. 159-160). List.
1919b. Estudios sobre Neurópteros (Insectes). *Arx. Inst. Cienc. Barcelona* 7: 179-203, 5 figs. (Psocids: pp. 197-198). Includes *Psocus arenosus* from Tonkin and says that *Amphigerontia nemianus* is a *Psocus.*
1920a. Insectos sud-americanos (la, 2a y 3a series). *An. Soc. cient. argent.* 90: 33-72, figs. 1-11. (Psocids: pp. 51, 63-64, fig. 6).
1920b. Insecta nova. 5, 6 y 7 series. *Mem. Accad. Nuovi Lincei* ser. II, 5: 21-29, figs. 21-30. (Psocids: pp. 27-28, fig. 29).
1920c. Socópteros nuevos. *Bol. Soc. ent. Esp.* 4: 90-94, 3 figs. Tonkin, Bolivia, Canary Is.
1920d. Notas entomológicas. ser. 2a. lb. Excursión anual de la Sociedad Aragosa de Ciencias Naturales al Valle de Ordesa (Huesca) 22-29 Julio de 1918. *Bull. Soc. ibér Cienc. nat.* 1920: 37-44. (Psocids: p. 43). List.
1921. Excursiones científicas realizadas el verano de 1920. *Congr. Oporto Assoc. Progr. Cienc.* 4: 59-74. (Psocids: pp. 68-69). List.
1922a. Insectos de la Argentina y Chile. *Estudios* 22: 358-368, 4 figs. (Psocoptera: pp. 364-367, figs. 2-4).
1922b. Algunos insectos de Chile. *Rev. chil. Hist. nat.* 21: 443-445, fig. 39. (Psocidae: pp. 444-445, fig. 39).
1922c. Algunos insectos del Museo de Paris. *Rev. Acad. Cienc. Zaragoza.* 7: 15-51, 16 figs. (Psocid: p. 19). *Psocus fuscipennis* mentioned from Brazil.
1922d. Insectos exoticos. *Broteria ser. zool.* 20: 49-63, 7 figs. (Psocids: pp. 56-61, figs. 4, 5).
1923a. Excursions entomologiques de l'Istiu de 1922. *Arx. Inst. Cienc. Barcelona* 8: 1-34, 13 figs. (Psocoptera: pp. 11-12, fig. 1).
1923b. Insecta nova. VIII series y Series IX y X. *Mem. Accad. Nuovi Lincei* 6: 1-27, figs. 34-36). (Psocids: pp. 22-23).
1923c. Travaux scientifiques de l'Amée d'Orient (1916-1918). Neuroptères. *Bull. Mus. Hist. nat.* 29: 84-90. (Psocid: p. 87). *Amphigerontia fasciata* mentioned.
1924a. Excursió Entomològica al Cabrerés (Girona-Barcelona). *Trab. Mus. Jta. nat. Barcelona* 4 (10): 1-59, 6 figs., 1 map. (Psocids: pp. 20-22, fig. 1). Description of *Valenzuela marianus* and list.
1924b. Mis excursiones entomológicas del verano de 1924. *Broteria ser. zool.* 21: 115-150, 14 figs. (Psocids: pp. 137-141, figs. 7-9).
1924c. Insectos de la America Central. *Broteria, ser. zool.* 21: 55-86, 22 figs. (Psocids: pp. 64-66, figs. 5-7).
1924d. Insectes de l'excursió de d. Ascensi Cardina a Castella i Andalusia, al Juny de 1923. *Publ. Jta. Cien. nat. Barcelona* 4 (11): 1-10, 2 figs. (Psocids: p. 8). 2 spp. listed.
1924e. Faune entomologique de l'Indochine française. Neuroptères de l'Indochine. *Opusc. Inst. sci. Indoch.* 8 (3): 125-161. (Psocoptera: pp. 160-161). *Amphigerontia namiana.*

1924f. Entomologie. *Rev. Quest. sci.* 1924: 1-11. (Psocoptera: p. 9). Mentions Tillyard, R. J. 1923.
1924g. Insecta orientalia. II Serie. *Mem. Pont. Accad. Sci. Nuovi Lincei.* 7: 211-216, fig. 3. (Psocoptera: pp. 215, 216, fig. 3). *Taeniostigma tibiale.*
1925a. Insectos exoticos nuevos a poco conocidos. *Mem. R. Acad. Barcelona.* 19 (5): 181-200, 24 figs. (Psocids: pp. 197-198, fig. 23). *Nescus flavatus.*
1925b. Neuropteren aus Brazilien. *Mitt. mũnch. ent. Ges.* 15 (1/5): 64-68, 3 figs. (Psocids: p. 68, fig. 3). *Psocus kotzbaueri.*
1925c. Quelques insectes des environs de Grenoble et des collections de l'Institut d'Hydrobiologie et le Pisciculture. *Assoc. franç. P. avanc. Sci.* 1925: 417-419. (Psocoptera: p. 418). List.
1926a. Algunos Insectos del Museo de Paris. 3a serie. *Broteria, ser. zool.* 23 (3): 95-115, figs. 10-21. (Psocoptera: pp. 98-99, fig. 11).
1926b. Insectos de la Argentina y Chile. Segunda serie. *Estudios* 26: 103-110, figs. 4-8. (Psocoptera: p. 109).
1926c. Algunos insectos del Brasil. 3e ser. *Broteria, ser. zool.* 23 (1):5-15, 5 figs. (Psocoptera: p. 15). 2 spp. listed.
1927a. Insetti raccolti nel Porto di Genova sulle Banane delle Canarie. *Boll. Soc. ent. Ital.* 59: 150-152, 2 figs.
1927b. Comunicaciones Entomológicas. 8. Socópteros del Museo de Hamburg. *Rev. Acad. Cienc. Zaragoza.* 11: 37-52, 9 figs.
1927c. Insecta orientalia. Series 5. *Mem. Accad. Nuovi Lincei* 10: 11-26, 15 figs. (Psocids: pp. 25-26, figs. 7-15). *Mindaus.*
1927d. Insectos de la Argentina y Chile. Tercera serie. *Estudios* 27: 22-28, figs. 9-10. (Psocoptera: pp. 27, 28, fig. 10).
1928a. Insectos de la Argentina. Cuarta serie. *Estudios* 28: 139-146, figs. 11-15. (Psocoptera: pp. 142-146, figs. 12-15).
1928b. Insectes nevroptères et voisins de Barbarie. Sixième serie. *Bull. Soc. nat. Hist. l'Afrique du Nord.* 19: 183-191, 5 figs. (Psocoptera: p. 189). *Myopsocus eatoni* listed.
1929a. Insectes Neuroptères et voisins de Normandie. *Assoc. franç. Avanc. des Ciences* 1929: 446-448, fig. 3. (Psocids: p. 447). *Psocus nebulosus* mentioned.
1929b. Insectos Neurópteros i afines. *Bol. Soc. ent. Esp.* 12: 38-42, 1 fig. (Psocids: p. 40). *Amphigerontia bifasciata* and *Graphopsocus cruciatus* from Palma.
1929c. Insectos del Brazil. 3a serie. *Rev. Mus. paul.* 16: 857-864, figs. 5-9. (Psocid: p. 864). *Psocus furcatus* Navas mentioned.
1929d. Excursiones por la provincia de Gerona en Julio y Augosto de 1928. *Bull. Inst. Catalana Hist. nat., ser. 2,* 9: 27-48, 1 fig. (Psocids: p. 34). 5 spp. listed.
1929e. Insetti Neurotteri ed affini di Oropa (Biella). *Bol. Soc. ent. Ital.* 61: 44-67, 2 figs. (Psocoptera: p. 45). *Psocus nebulosus* listed.
1930a. Excursió entomológica a la vall de Noguera de Cardós (Lleida). *Bull. Inst. Catalana Hist. nat., ser. 2,* 10 (9): 156-169, 6 figs. (Psocoptera: p. 156). *Graphopsocus cruciatus.*
1930b. Insectos neotropicos (Sexta serie). *Rev. chil. Hist. nat.* 34: 299-307, figs. 58-64. (Psocids: pp. 303-307, figs. 61-64). 5 spp. n. mentioned.
1930c. Excursión a Ribera de Cardós, Pallaris (Lérida). *Bull. Inst. Catalana Hist. nat.* (2) 10 (3): 48-57, 5 figs. 3 spp. listed.
1931a. Nevroptères et insectes voisins — Chine et pays environnants. *Notes Ent. chin.* 7: 1-10, figs. 10-17. (Abstract in *Lignan Sci. J. Canton* 10: 530 [1931]). (Psocids: p. 5, fig. 13). *Psocus taprobanes* var. *orientalis.*
1931b. Insectos de la Argentina. Septima serie. *Rev. Soc. ent. argent.* 3: 317-324, 7 figs. (Psocids: pp. 320-321). 1 sp.n.
1931c. Insectos Neurópteros y afines de la Lorena (Francia). *Broteria, ser. zool.* 27: 136-144, 1 fig. (Psocids: p. 140).

1931d. De mis últimas excursiones entomológicas. (1930-1931). *Boll. Soc. ent. Esp.* 14: 116-130, 4 figs. (Psocids: pp. 121-122).
1931e. Insectes du Congo Belge (Ser. VI). Nevroptères. *Rev. Zool. Bot. afr.* 21: 123-144, figs. 64-79. (Psocoptera: pp. 131-133, figs. 68, 69).
1932a. Insectos de la Argentina. *Rev. Acad. Cienc. Zaragoza* 16: 87-120, 22 figs. (Psocoptera: pp. 97-111, figs. 4-15).
1932b. Alcuni Insetti del Museo di Zoologia della R. Universita di Torina. *Boll. Mus. zool. Anat. comp. Torina* (3) 42 (26): 1-38, 32 figs. (Psocids: p. 28). 2 spp. listed.
1932c. Faunula de la Sobradiel (Zaragoza). *Rev. Acad. Cienc. Zaragoza* 16: 11-28, 9 figs. (Psocoptera: p. 16). 5 spp. listed.
1932d. Insectos de la Argentina y Chile. *Rev. Soc. ent. argent.* 5: 77-86, figs. 9-15. (Psocids: pp. 81-82, fig. 11).
1932e. Insectes du Congo Belge. Serie VII. *Rev. Zool. Bot. afr.* 22: 269-290, figs. 70-87. (Psocoptera: pp. 281-283, figs. 80, 81).
1933a. Nevroptères et insectes voisins. Chine et pays environnants. *Notes Ent. chin.* 9: 1-22, figs. 22-36. (Psocoptera: p. 14, fig. 30).
1933b. Nevroptères et insectes voisins. Chine et pays environnants. Cinquième serie. *Notes Ent. chin.* 13: 1-10, figs. 37-42. (Psocids: pp. 6-7, fig. 40). *Amphigerontia diffusa.*
1933c. Insetti Neurotteri e affini del Piemonte. *Mem. Soc. Ent. Ital.* 12: 150-162, 9 figs. (Psocoptera: p. 152). List.
1933d. Décadas de insectos nuevos. Decada 24. *Broteria, ser. zool.* 2 (3): 101-110, figs. 96-102. (Psocids: pp. 108-109, fig. 101). *Elipsocus nevermanni.*
1933e. Recoltes entomologiques en Holland. *Rev. Mens. Belg. d'Ent.* 33: 20-25. (Psocids: p. 24). 10 spp. listed.
1933f. Neuroptères et insectes voisins. Chine et pays environnants. *Notes Ent. chin.* 1: 1-22, 3 figs. (Psocids: pp. 14-15).
1934a. Insectes de la India. *Rev. Acad. Cienc. Zaragoza* 17: 29-48, figs. 35-48. (Psocids: pp. 34-38 ,figs. 37-39).
1934b. Neuroptères et insectes voisins. Chine et pays environnants. Septième serie. *Notes Ent. chin.* 2: 1-16, figs. 46-53. (Psocids: pp. 7-9, fig. 49).
1934c. Insectos suramericanos. Novena serie. *Rev. Acad. cienc. Madr.* 31: 155-184, figs. 33-55. (Psocids: pp. 158-159, fig. 34).
1934d. Insects del Museo de Hamburgo. 2a Serie. *Mem. R. Acad. Barcelona* 23: 497-508, 9 figs. (Psocids: p. 508). 1 sp. mentioned.
1934e. Insectos suramericanos. Octavo serie. *Rev. Acad. cienc. Madrid* 31: 9-28, figs. 25-39. (Psocoptera: pp. 20-22, figs. 32, 33).
1936. Insectes du Congo Belge. Serie IX. *Rev. Zool. Bot. afr.* 28: 333-368, 48 figs. (Psocoptera: pp. 361-363, figs. 117-118).

Needham, J. G.

1909. Notes on the Neuroptera in the collection of the Indian Museum. *Rec. Indian Mus.* 3 (3): 185-210, 4 figs., pls. XIX-XXI. (Psocids: pp. 192-193).

Newman, E.

1866a. Ticking of the Death-Watch. *Entomologist* 3: 65-66.
1866b. Psocus bred from *Atropos pulsatorius. Entomologist* 3: 66. Describes the emergence of a minute psocid *(P. pulicarius)* from specimens of *Atropos pulsatorius.*

Newstead, R.

1921. Corrodentia: Psocidae. On a new Southern Nigerian Psocid. *Trans. ent. Soc. Lond.* 1921 (3/4): 452-454, 1 fig., pl. XI.

Nitsch, C. L.

1821. Ueber die Eingeweide der Bűcherlaus *(Psocus pulsatorius)* und űber das Verfahren bei der Zergliederung sehr kleiner Insekten. *Germar's Magaz. Entom.* 4: 276-290, pl. 2.

Noland, R. C.

1924. The anatomy of *Troctes divinatorius* Muell. *Trans. Wis. Acad. Sci. Arts Lett.* 21: 195-211, pls. IV-VI.

Nordberg, S.

1936. Biologischőekologische Untersuchungen űber die Vogelnidicolen. *Act. Zool. Fenn.* 21: 1-168, 4 figs.

Nordman, A.

1935. *Enumeratio Insectorum Fenniae.* Helsingfors. (Copeognatha: Vol. 4, pp. 9-10). List.

Nowicki, M.

1865. *Insecta Haliciae Musei Dzieduszyckiani* Krakow. 87 pp.

Nyholm, T.

1950. Till kännedomen om den svenska copeognatfaunan. I. Tva főr vår fauna nya arter av släktet *Peripsocus* Hagen. *Ent. Tidskr.* 71: 194-198, 2 figs. Swedish records and key to *Peripsocus* spp. in Sweden.

1953a. Zur Kenntnis der Copeognathenfauna Schwedens. 2. Die Schwedischen Arten der Gattungen *Trichadenotecnum* End. sensu Roesler. *Ark. Zool. (N.S.)* 4: 297-302, 5 pls.

1953b. Zur Kenntnis der Copeognathenfauna Schwedens. 3. Verzeichnis der bisher in Schweden gefundenen Copeognathen. *Ent. Tidskr.* 74: 108-115. Records and list of 53 spp. from Sweden.

Obernberger, J.

1955. *Entomology.* 4 vols. Prague. Vol. II, 726 pp., 801 figs., 9 pls. (Psocoptera: II (65): pp. 638-675, figs. 747-795).

Obr, S.

1948a. Contribution à la connaissance d'espèce de *Peripsocus didymus* Roes. (Psocopt.). *Sborn. Kl. přir. Brně* 28: 54-56, 2 figs. (In Czech with French summary).

1948b. A la connaissance des Psocoptères de Moravie (Tchécoslovaquie). *Publ. Fac. Sci. Univ. Masaryk* 360, 108 pp., 196 figs. (In Czech with French summary). External anatomy, biology, study methods, keys, descriptions, illustrations to spp. in Moravia. New forms described in French summary.

1949. Psocoptera from the Silesian Jeseníky and Králicky Sněžnik (Czechoslovakia). *Sborn přir. Společ. Mor. Ostravé.* 10 (3): 1-16, 7 figs. (In Czech with English summary).

1951a. Psocoptères de Slovaquie (Tchécoslovaquie). 1. La Haut Tatra. *Publ. Fac. Sci. Univ. Masaryk* 330: 209-219. (In Czech with French summary).

1951b. Psocoptères de Slovaquie (Tchécoslovaquie). 2. L'environ de Čilistov près de Bratislava. *Publ. Fac. Sci. Univ. Masaryk* 330: 221-229, 15 figs. (In Czech with French summary).

1951c. Deuxième contribution à la connaisance des Psocoptères de Moravie. *Sborn Kl. přir. Brně.* 29: 105-119, 7 figs. (In Czech with French summary).

1951d. *Trichadenotecnum incognitum* Roes., une nouvelle espèce des Psocoptères pour la Tchécoslovaquie. *Sborn. Kl. přir. Brně* 29: 255-258, 5 figs.

1952. Psocoptera from the Silesian Beskydy (Czechoslovakia) *Sborn přir. Společ. Mor. Ostravé* 13: 216-231, 6 figs. (In Czech with English summary).

1954. Contribution à la connaissance des Psocoptères de la Silésie. *Sborn. přir. Společ. Mor. Ostravé* 15: 269-283, 7 figs. (In Czech with French summary).

1957. Contribution to the study of Psocoptera on the Kotouč Hill near Stramberk and its near neighborhood (ČSR). *Sborn přír. Společ. Mor. Ostravé* 18 (4): 514-519. (In Czech with English and Russian summaries).

1958. Troisième contribution à la connaissance des Psocoptères de Moravie. (Tséchoslovaquie). *Sborn. Kl. přír. Brně* 30: 53-61. (In Czech with French summary).

Ogilvie, L.

1928. *The insects of Bermuda.* Bermuda. 52 pp. (Corrodentia: p. 11). 2 spp. listed.

Okamoto, H.

1906. On the Psocidae of Japan. *Trans. Sapporo nat. Hist. Soc.* 1: 197-199. (In Japanese).

1907. Die Psociden Japans. *Trans. Sapporo nat. Hist. Soc.* 2: 113-147, pl. II. (Reference given wrongly in Zoological Record as *J. Tohoku Imperial University*).

1910. Die Caeciliiden Japans. *Ann. hist. — nat. Mus. hung.* 8: 185-212, pls. III-V. Caeciliidae *sens. lat.*

Okamoto, H. and **Kuwayama,** S.

1924. A contribution to our knowledge of the Corrodentia fauna of South Saghalien. *Ann. Mag. nat. Hist.* (9) 14: 486-489, 1 pl.

Olfers, E. von

1905. Flűgellose Arthropoden des Bernstein in ihrer Beziehung zur Decendenztheorie. *Schr. Ges. Kongisb.* 46: 100-104.

Orosi-Pal, Z.

1938. Copeognathen (Flechtlinge) in der Bienenwohnung. *Z. angew. Ent.* 24: 644-646, 1 fig. *Trogium pulsatorium, Liposcelis divinatorius* and *Lepinotus inquilinus* in experimental apiary.

Packard, A. S.

1869. *Guide to the study of Insects and a treatise on those injurious and beneficial to crops. For the use of Colleges, Farm-Schools and Agriculturalists.* Salem.

1870. New or rare American Neuroptera, Thysanoptera and Myriapoda. *Proc. Boston Soc. nat. Hist.* 13: 405-409.

1885. Dr. Brauer's views on the classification of Insects. *Amer. Nat.* 19: 999-1001.

1889a. Notes on the epipharynx and the epipharyngeal organs of taste in mandibulate insects. *Psyche, Camb., Mass.* 5: 193-199, 222-228. (Psocids: p. 222). *Psocus novascotiae* and *Psocus* sp.

1889b. The Cave Fauna of North America, with remarks on the anatomy of the Brain and Origin of the Blind species. *Mem. nat. Acad. Sci.* 4: 3-156, pls. 1-27. (Psocids: pp. 72-73, 83, pls. 17, figs. 4, 4a and 4b).

Pant, G. D.

1953. See Roonwal, M. L. et al. 1953.

Panzer, G. W.

1805. *Faunae insectorum Germaniae initia oder Deutschlands insecten.* Nurnberg. 1790-1813. 109 pts.

Parfitt, E.

1879. The fauna of Devon, Neuroptera. *Rep. Devon Ass. Adv. Sci.* 11: 386-421. Local list.

Patton, W. S.

1930. *Insects, Ticks, Mites and Venomous animals of Medical and Veterinary Importance*. London. (Psocoptera: Part II, pp. 412-423).

Paulian, R.

1952. See Badonnel, A. 1952.

Pax, F. and **Maschke,** K.

1935. Die Höhlenfauna des Glatzer Schneeberges. i. Die rezente Metazoenfauna. *Beit. Biol. Glatzer Schneeberges* 1: 4-72, 22 figs. *Trogium pulsatorium* in cellar.

Pearman, J. V.

1923. *Pteroxanium squamosum* near Bristol. *Ent. mon. Mag.* 59: 162.
1924a. A new species of *Caecilius* (Psocoptera). *Ent. mon. Mag.* 60: 58-61, 3 figs. *C. corticis,* England.
1924b. Two *Psocids* new to Britain. *Ent. mon. Mag.* 60: 121-124, 6 figs. *Psyllipsocus ramburi* and *Pseudopsocus rostocki.*
1924c. *Caecilius corticis* Pearm.: synonymical note. *Ent. mon. Mag.* 60: 213.
1925a. Additions to the British Psocid Fauna. *Ent. mon. Mag.* 61: 124-129, 2 figs.
1925b. *Caecilius corticis* Pearman: synonymy and notes. *Ent. mon. Mag.* 61: 203-206, 4 figs.
1926. A short account of British Psocids. *Ann. Rept. Bristol Nat. Soc.* 6 (3): 222-228, 1 pl.
1927. Notes on *Pteroxanium squamosum* Endl. and on the eggs of the Atropidae (Psocoptera). *Ent. mon. Mag.* 63: 107-111, 8 figs.
1928a. Some Psocoptera from the New Hebrides. *Ent. mon. Mag.* 64: 133-137, figs. 1-9.
1928b. On sound production in the Psocoptera and on a presumed stridulatory organ. *Ent. mon. Mag.* 64: 179-186, 1 fig.
1928c. Biological observations on British Psocoptera. *Ent. mon. Mag.* 61: 209-218, 239-243, 263-268.
1928d. Life-history of *Psocus sexpunctatus* (Linn). *Proc. Bristol Nat. Soc.* (4) 6 (5): 384-387.
1928e. *Pseudopsocus rostocki* Kolbe. a further record. *Ent. mon. Mag.* 64: 261. Occurrence in England.
1928f. *Lepidilla kelloggi* Rib. (Pteroxanium squamosum End.): a new locality. *Ent. mon. Mag.* 64: 261. Range in England and beyond.
1929a. Additional notes on Psocid biology (oviposition). *Ent. mon. Mag.* 65: 89-90.
1929b. Specimens illustrating the methods of oviposition in the Psocoptera. *Proc. ent. Soc. Lond.* 3: 66-67. Relates to an exhibit at the meeting of October 17th, 1928, illustrating the egg deposition described in Pearman, J. V. 1928c.
1929c. Lives of the Psocidae. *Ann. Rept. Bristol Nat. Soc.* 12: 20-21. Feeding, mating.
1929d. New species of Psocoptera from warehouses. *Ent. mon. Mag.* 65: 104-109, 10 figs. England.
1931a. A new species of *Lepinotus* (Psocoptera). *Ent. mon. Mag.* 67: 47-50, 4 figs. *L. patruelis,* England.
1931b. *Lepinotus patruelis*: further note. *Ent. mon. Mag.* 67: 50.
1931c. More Psocoptera from warehouses. *Ent. mon. Mag.* 67: 95-98, 2 figs.
1932a. Notes on the genus Psocus, with special reference to the British species. *Ent. mon. Mag.* 68: 193-204, 37 figs. Characters given for *Psococerastis, Metylophorus, Psocus, Trichadenotecnum, Loensia, Amphigerontia, Euclismia, Clematostigma.*
1932b. Some coccophagous Psocids (Psocoptera) from East Africa. *Stylops* 1 (4): 90-96, 8 figs.

1932c. A new species of *Tapinella* (Psocoptera). *Stylops* 1 (11): 240-242, 1 fig.
1933a. A Psocid allied to *Eremopsocus infumatus* McLachlan (Psocoptera). *Stylops* 2 (7): 159-161, 11 figs. Venezuela.
1933b. Further Notes on *Lepidilla kelloggi* Ribaga. *Ent. mon. Mag.* 69: 22. Distribution, seasonal cycle.
1933c. A new species of *Terracaecilius* (Psocoptera). *Ent. mon. Mag.* 69: 81-83, 2 figs. England.
1934a. A new species of *Archipsocus* (Psocoptera). *Stylops* 3 (5): 112-113, 7 figs. Ceylon.
1934b. New and little known African Psocoptera. *Stylops* 3 (6): 121-132, 12 figs.
1935a. Notes on some dimorphic Psocids. *Ent. mon. Mag.* 71: 82-85, 1 fig. *Embidotroctes, Psoquilla, Psyllipsocus, Bertkauia.*
1935b. Two remarkable Amphientomids (Psocoptera). *Stylops* 4 (6): 134-137, figs. A, B. 2 spp. *Nephax,* South Africa, Palestine.
1936a. The Taxonomy of the Psocoptera: Preliminary Sketch. *Proc. R. ent. Soc. Lond. (B)* 5: 58-62. Conspectus of reclassification of the order.
1936b. Two new Psocids from Ceylon. *Spolia zeylan.* 20: 1-7, 1 pl.
1942. Third note on Psocoptera from warehouses. *Ent. mon. Mag.* 78: 289-292, 3 figs.
1946. A specific characterization of *Liposcelis divinatorius* (Mueller) and *L. mendax* sp.n. (Psocoptera). *Entomologist* 79: 235-244, 18 figs.
1951. Additional species of British Psocoptera. *Ent. mon. Mag.* 87: 84-89, 7 figs. *Troctes* spp., *Peripsocus* spp.
1952. Nomenclature of some British Psocoptera. *Ent. mon. Mag.* 88: 150. *Troctes* Burmeister and identity of *Atropos kidderi* Hagen discussed. cf. Broadhead, E. 1952.
1953. A new generic form allied to *Sphaeropsocus* Hagen (Psocoptera, Pachytroctidae). *Ent. mon. Mag.* 89: 262. *Badonnelia titei.*
1955a. See Sommerman, K. M. and Pearman, J. V. 1955.
1955b. The eggs of *Mesopsocus unipunctatus* (Muell.) (Psocopt. Mesopsocidae). *Ent. mon. Mag.* 91: 206.
1958a. Psocoptera. *Res. Norv. sci. Exp. Tristan da Cunha* 1937-1938, 45: 2-3.
1958b. Augmented description of *Badonnelia titei* Pearman (Psoc. Sphaeropsocidae) with notes on the genus *Sphaeropsocus. Ent. mon. Mag.* 94: 49-52, 13 figs. Includes key to families of Nanopsocetae.
1960. Some African Psocoptera found on rats. *Entomologist* 93: 246-250, 6 figs.

Pearse, A. S.
1938. Fauna of the caves of Yucatan. XVIII. Insects from Yucatan Caves. *Publ. Carneg. Instn.* 491: 237-249. (Corrodentia: p. 238). *Psyllipsocus ramburi.*

Peck, O.
1951. Superfamily Chalcidoidea. *In* Muesebeck, C. F. W., Krombein, K. V. and Townes, H. K. Hymenoptera of North America north of Mexico, Synoptic catalog. *Dep. Mon. U.S. Dep. Agric.* 2, 1420 pp., 1 map.

Pemberton, C. E.
1942. *Liposcelis divinatorius* Műll. *Proc. Hawaii. ent. Soc.* 11 (2): 145.

Perkins, R. C. L.
1899. *Fauna Hawaiiensis.* Cambridge. (Psocidae: Vol. 2 (2): pp. 77-87).

Perrier, R.
1934. *Faune de la France en tableaux synoptiques illustré.* Paris. 2e edition. (Psocoptera: Vol. 3, pp. 72-76, 8 figs.).

Peus, F.

1933. Flechtlinge als Wohnungs- und Materialschädlinge besonders in Neubauten. *Z. GesundhTech. Städtehyg.* 25: 483-490, 1 fig. Spp. occurring in houses in Germany, control. cf. *Rev. appl. Ent. (A)* 21: 532-533, 1933 (Review in English).

Peyerimhoff, P. de

1901. Le méchanisme de l'éclosion chez les Psoques. *Ann. Soc. ent. Fr.* 70: 149-152, 1 fig. *Stenopsocus cruciatus* (L.).

Pictet, A. E.

1865. *Synopsis des Neuroptères d'Espagne.* Geneva. 123 pp.

Pictet, F. J.

1854. *Traité de Paléontlologie ou Histoire naturelle des Animaux fossiles considérés dans leur Rapports zoologiques et geologiques.* Paris. 2e edition. (Psocoptera: Vol. 2, p. 376, pl. XL, fig. 27).

Pliginsky, V. G.

1915. Pests of collections and their control. *Bull. Charkov. Soc. of Friends of Nature* 3: 73-76.

Pongracz, A.

1913. Újabb adatok Magyarország Neuroptera-fauná-jához. *Rovart. Lapok.* 20: 175-186.

1914. Die Neuropteroiden Ungarns. *Rovart. Lapok.* 21: 109-155. (In Hungarian with German summary). (Psocoptera: pp. 116-118).

1919. Beiträge zur Pseudoneuropteren-und Neuropteren-fauna Polens. *Ann. Hist. -nat. Mus. Nat.* 17: 161-177.

Pongracz, S.

1943. See Dudich, E. et al. 1943.

Porter, C. E.

1939. Entomologica chilena. Localidades neuvas de algunas especies. *Rev. chil. Hist. nat.* 42: 166-169, illustr. *Ectopsocus briggsi* wing illustrated.

Pravdin, T.

1932. Beiträge zur Kenntnis des Baues des Kopfes der Insekten — Zum Bau des Kopfes des Copeognathen. *Zool. J. Moscow* 11: 159-172, 14 figs. (In Russian with German summary).

Priesner, H.

1926. Holz- und Bűcherlaűse (Copeognatha) aus Oberősterreich und Steiermark. *Jber. oberőst. Musealver* 81: 369-376.

Provancher, L.

1876. Petite Faune entomologique du Canada. Les Neuroptères. *Nat. canad.* 8: 177-187 (Psocids: pp. 181-187).

Puschnig, R.

1923. Beiträge zur Kenntnis der Psociden-fauna Karntens. *Carinthia II.* 136: 112.

Quezel, P., **Rioux,** J. A. and **Verdier,** P. H.

1949. Les Psocoptères dans la biocénose hivernale des écorces de platane (Région de Montpellier). *Feuille Nat. (N.S.)* 4: 87-88.

Rabeler, W.
1931a. Die Fauna des Gőldenitzer Hockmoores in Mecklenberg. *Z. Morph. Ökol. Tiere* 21:173-315, 7 figs. (Psocids: p. 222).
1931b. Bemerkungen zur Psocidenfauna Mecklenbergs. *Arch. Ver. Naturg. Mecklenb. N.F.* 5: 45-50.

Rambur, J. P.
1842. *Histoire naturelle des Insectes. Neuroptères. Nouvelles suites a Buffon,* Paris. xvii, 534 pp. 12 pls.

Rapp, W. F.
1961. Corrodentia in cliff swallows nests. *Ent. News* 72 (7): 195. *Liposcelis bostrychophilus.*

Ray, J.
1710. *Historia insectorum; opus posthumum.* London. (Psocid: p. 8).

Redtenbacher, J.
1886. Vergleichende Studien über das Flűgelgeäder der Insekten. *Ann. naturh. (Mus.) Hofmus. Wien* 1: 153-232, pls. IX-XX. (Corrodentia: pp. 183-184, pl. XII, figs. 35-38).

Reichmuth, W.
1938. Die Schadwirkungen der Flechtlinge (Copeognatha) unter Berűcksichtigung der Entwicklung und ihrer abhängigkeit von Feuchtigkeit und Temperatur. *Mitt. Ges. Vorratsschutz* 14 (5): 57-63.

Reuter, O. M.
1894. Corrodentia Fennica. I. Psocidae. Főrteckning och beskrifning őfver Finlands Psocider. *Act. Soc. Fauna Flora fenn.* 9 (4): 1-49, 1 pl. Lists 41 spp., keys, descriptions, distribution.
1899. Antechningar om Finska Psocider. *Act. Soc. Fauna Flora fenn.* 17 (3): 1-7. Lists 7 spp.
1904. Neue Beiträge zur Kenntnis der Copeognathen Finnlands. *Act. Soc. Fauna Flora fenn.* 26 (9): 1-28, 3 pls. Deals with 17 spp.
1909. Mitteilungen über einige finländische Copeognathen. *Medd. Soc. Fauna Fl. fenn.* 35: 204-210. Lists 10 spp.

Ribaga, C.
1899a. Descrizione di nuovo genere e di una nuovo specie di Psocidi trovato in Italia. *Riv. Pat. veg., Padova* 8: 156-159, pl. 7.
1899b. Osservazioni sull' anatomia del *Trichopsocus dahli* MacL. Nota preventiva. *Riv. Pat. veg., Padova* 8: 370-374.
1900a. Una specie nuova di Psocide trovata in Italia. *Riv. Pat. veg., Padova* 8 (2): 364-366, 1 fig.
1900b. Contributo alla conoscenza Psocidi italiani. *Riv. Pat. veg., Padova* 8: 375-386.
1901. Osservazioni circa l'anatomia de *Trichopsocus dalii* McLachl. *Riv. Pat. veg., Padova* 9: 129-176, 6 pls.
1904. Sul genere *Ectopsocus* McLach. e descrizione di una nuova varietà dell' *Ectopsocus briggsi* MacLach. *Redia* 1: 294-298.
1905a. La partenogenesi nei Copeognati. *Redia* 2:. 33-36. *Ectopsocus briggsi* var. *meridionalis.*
1905b. Descrizione di nuovi Copeognati. *Redia* 2: 99-110, pls. IX, X. California; Italy.
1907. Copeognati nuovi. *Redia* 4: 1-9, pl. IV. 2 spp., Italy.
1908a. Un nuovo Copeognato dell'Isola di Giava. *Redia* 5: 20-26, pl. II.
1908b. Copeognati Estraeuropi del Museo Civico di Storia Naturale di Genova. *Redia,* 5: 98-109, pl. VI. Argentine, East Indies, Uraguay, Paraguay, Bolivia, New Guinea.

1910. *"Anisopsocus lichenophilus"*, nuovo Copeognato, trovato in Italia. *Redia* 6: 272-281, 8 figs.
1911. Nuovi Copeognati Sudafricani. *Redia* 7: 156-171, 12 figs.

Richards, O. W.
1943. The habitat of species of *Ploiariola* (Heteroptera-Reduviidae). *Proc. R. ent. Soc. Lond. (C)* 8 (7): 22. *Ploiariola vagabunda* eating *Liposcelis* sp. and probably other psocids.
1957. See Imms, A. D. 1957.

Richards, O. W. and **Herford,** G. V. B.
1930. Insects found associated with cacao, spices and dried fruits in London warehouses. *Ann. appl. Biol.* 17: 367-395.

Richards, O. W. and **Waloff,** N.
1958. Psocoptera captured on broom at the Imperial College Field Station, Silwood Park, Berks. *Ent. mon. Mag.* 94: 150. List and remarks on abundance.

Rimsky-Korsakov, M.
1922. Ueber einiger flűgellose Copeognathen. *Rev. russe Ent.* 18: 20-21. (In Russian with German summary). 5 spp. listed from St. Petersburg.
1948. *In* Tarbinskii, S. P. Identification of the Insects of the European part of the U.S.S.R. Moscow. 1127 pp., illustr. (Corrodentia: pp. 151-154).

Ringuelet, R. A.
1955. Ubicacion zoogeografica de las Islas Malvinas. *Rev. Mus. La Plata (N.S.)* 6: 419-464, 8 figs.

Rioux, J. A.
1949. See Quezel, P. et al. 1949.
1953. Invasion de psoques dans une collection de champignons levuriformes. *Ann. parasit. humaine et comp.* 28 (3): 239-240. *Liposcelis bostrychophilus.*

Ritsema, C.
1872. (Notes an instance recorded in *Arch. path. Anat.* 1871, p. 238 of immense numbers of *Clothilla inquilina* appearing in an old house in August). *Album. der Nat.* 1872: 255.

Robins, E. L. D.
1945. See Hickin, N. E. and Robins, E. L. D. 1945.

Rodendorf, B. B.
1961. See Becker-Migdisova, E. E. 1961.

Roemer, J. J.
1789. *Genera insectorum Linnaei et Fabricii Iconibus illustrata.* Vitoduri. i-viii, 86 pp., 37 pls. (Psocids: pp. 32, 55, 56, pl. xxiv, figs. 12, 13; pl. xxix, figs. 3, 3b.) The plates of this book are the same as those in Sulzer, J. H. 1776.

Roepke, W.
1926. Vorratsschädlinge auf Java. *Mitt. Ges. Vorratsschutz* 2 (5): 50-53. Psocids occurring everywhere.

Roesler, R.

1935a. *Reuterella neglecta* nov. spec., eine neue rindenbewohnende Copeognathen-Art. *Zool. Anz.* 111 (3/4): 93-95, 8 figs.

1935b. Zur Kenntnis der Mecklenbergischen fauna VII. 22. Die Copeognathen Mecklenbergs. *Arch. mecklenberg. Naturf.* 9: 18-30. *Reuterella neglecta* n. sp. Brief description, full description to follow in *Zool. Anz.* Notes on life history of other spp.

1937a. Zur Copeognathenfauna Pommerns. *Dohrniana* 16: 61-74.

1937b. Zur Kenntnis der mecklenbergischen Fauna IX. 31. Ein Nachtrag zur Copeognathen-Fauna Mecklenbergs. *Arch. mecklenberg. Naturf.* 11: 65-69.

1939a. Beiträge zur Kenntnis der Copeognathenfauna Deutschlands. *Zool. Anz.* 125 (7/8): 157-176, 16 figs.

1939b. *Trichadenotecnum incognitum* nov. spec. eine neue deutsche Psocide. *Zool. Anz.* 127 (3/4): 109-112, 6 figs.

1940a. Neue und wenig bekannte Copeognathengattungen I. *Zool. Anz.* 129 (9/10): 225-243, 39 figs. Mainly South American spp. mentioned. *Trichempheria, Psoquilla,* Tapinellinae, *Psyllotroctes,* Pachytroctinae, Electrentominae, Amphientominae, Plaumannidae, Ptiloneuridae.

1940b. Neue und wenig bekannte Copeognathengattungen II. *Zool. Anz.* 130 (1/2): 1-25, figs. 40-101. Spp. from South America, Formosa. Gojinae, Neurostigminae, Epipsocinae, Thyrsophorinae, Pseudocaeciliidae, Polypsocidae (sens. Roesler).

1940c. Neue Copeognathen. *Arb. morph. taxon. Ent. Berl.* 7 (3): 236-244, 2 figs. Ptiloneuridae; family divisions of Psocetae; subfamilies and tribes of Psocidae; Mesopsocidae; divisions of Pseudocaeciliidae (sens. Roesler).

1943. Über einige Copeognathengenera. *Stettin. ent. Ztg.* 104: 1-14, 13 figs. Psocidae: Amphigerontiini, Psocini, Metylophorini; Pseudocaeciliidae: Peripsocinae. Division of some *Amphigerontia* spp. and several name changes in genera and spp.

1944. Die Gattungen der Copeognathen. *Stettin. ent. Ztg.* 105: 117-166. Discussion on classification and key to genera of world.

1952. *In* Eichler, W. 1952 *Die Tierwalt der Gewachshauser.* Leipzig, i-iv, 93 pp., 11 figs. (Psocoptera: p. 34).

1953. Zwei neue *Lachesilla*-Arten (Psocoptera). *Ent. Ber., Amst.* 14: 295-300, 15 figs. South Russian spp.

1954a. Über Parthenogenese und Voltinismus bei Psocopteren. *Bericht 7. Wanderversammlung Deutscher Entomologers. 8 bis 10 September 1954 in Berlin*: 165-167.

1954b. Neue Gattungen und Arten der deutschen Psocopteren-fauna (Psocoptera). *Beit. Ent.* 4 (4/5): 559-574, 24 figs.

Rolander, D.

1754. Beskrifung på Vägg-Smeden (*Atropos*). *Vetensk. Acad. Handl.* 15: 152-156. Rolander, D. 1786 is a translation into German.

1786. Beskrifung på Vägg-Smeden (*Atropos*). *Abstr. Füessly Neu. Mag.* 3: 38-40. (In German). This is a translation of Rolander, D. 1754.

Roonwal, M. L., **Mather,** R. N., **Bhasin,** G. D., **Singh,** B., **Pant,** G. D. **Chandra,** A., **Katiyar,** K. and **Mathur,** R. K.

1953. A systematic account of the main identified entomological collection at the Forest Research Institute, Dehra Dun, Pts. 9-21. Orders Isoptera, Embioptera, Psocoptera, Anoplura, Ephemeroptera, Odonata, Thysanoptera and Hemiptera. *Forest Res. Inst. Indian Forest Lflt.* 121 (3): (Ent.): 39-187.

Rosen, K. von.

1910. Beitrag zur Copeognathen-Fauna Ostpreussens. *Konigsberg Schr. physik. Ges.* 51 (3): 330-338. List.

1911. Mitteilungen über südeuropäische Copeognathen. *Munchen Mitt. ent. Ges.* 1911 (1/2): 8-11, 6 figs.

Rosewall, O. W.

1930. The Biology of the booklouse *Troctes divinatoria* Müll. *Ann. ent. Soc. Amer.* 23: 192-194, 1 fig.

Rostock, M.

1868. Verzeichniss sächsischer Neuropteren. *Berl. ent. Z.* 12: 224-226. (Psocidae: p. 226). 10 spp. listed.

1876. Psocidenjagd im Hause. *Ent. Nachr.* 2: 190-192.

1878. Die Ephemeriden und Psociden Sashsens mit Berücksichtigung des meisten übrigen deutschen Arten. *Jber. Ver. Naturk. Zwickau* 1877-1878: 76-100. (Review in *S.B. Ges. Isis* 1878: 178).

1879a. Die Netzflügler Sachsens. *S.B. Isis Dresden* 1879: 70-91. 26 spp.

1879b. Ueber eine besondere nordrussische Psocus-Art. *Ent. Nachr.* 5: 129-130.

1881. Verzeichniss der Neuropteren Deutschlands, Oesterreichs und der Schweiz. *Ent. Nachr.* 7: 217-228. (Psocids: pp. 227-228). (See also Kolbe, H. 1881b.) List of Neuroptera of Germany.

1888. See Kolbe, H. 1888b.

Sala, I.

1928. Reflexiones sobre la labor cientifica del R.P. Longinos Navas, S. J. *Rev. Acad. Cienc. Zaragoza* 12: 123-175. (Biblio. Naturalistica: pp. 133-162). Bibliography of papers by Navas, L. until 1927.

Saunders, E.

1905. Psocidae at Woking. *Ent. mon. Mag.* 41: 213. 22 spp. listed.

Schaeffer, J. C.

1766. *Elementa Entomologica; 135 tabulae aere excusae floridique coloribus distinctae.* Ratisbon.

1779. *Icones Insectorum circa Ratisbonam indigenorum coloribus naturam referentibus expressae.* Regensburg. 3 vols. (Psocoptera: vol. 3, fig.).

Schille, F.

1902. Materyały do fauny owadów siatkoskrzydłych i szarańczaków doliny Popradu. *Spraw. Kom. fizjogr., Kraków* 36: 77-95.

1904. Eine neue Psociden-Varietat. *Zool. Anz.* 27: 475-476.

1905. Materyały do fauny owadów siatkoskrzydłych i szarańczaków doliny Popradu. Czesć III. *Spraw. Kom. fizjogr., Kraków* 38: 36-39.

1907. Materyały do fauny owadów siatkoskrzydłych i szarańczaków doliny Popradu. Czesć IV. *Spraw. Kom. fizjogr., Kraków* 40: 43-45.

1911. Materyały do fauny owadów krajowych. *Spraw. Kom fizjogr., Kraków* 45: 11-38, 1 pl.

1912. Materyały do fauny owadów krajowych. II. *Spraw. Kom. fizjogr., Kraków* 46: 123-131.

Schneider, H.

1954. Vergleichende Untersuchungen über Parthenogenese und Entwicklungsrhythmen bei Psocopteren. *Zool. Anz.* 151 (5/6): 105-110. European spp.

1955. Vergleichende Untersuchungen über Parthenogenese und Entwicklungsrhythmen bei einheimischen Psocopteren. *Biol. Zbl.* 74: 273-310, 4 figs.

Schneider, W. G.
1885. Verzeichniss der Neuropteren Schlesiens. *Ent. Bresl.* (2) 10: 17-32.

Schouteden, H.
1918. Psocides tisseurs au Congo. *Rev. zool. afr.* 5 (3): 169-171.

Schrank, F.
1776. Abbildung einiger Insecten, von denen meines Wissens noch keine, oder keine gute Zeichnung gemacht worden ist. (Diptera, Hemiptera, Atropos). *Schrank Beitrage* 1776: 42-59, fig.
1781. *Enumeratio insectorum Austriae indigenorum.* August. Vindelicor., Klett. ix, 548 pp. 4 pls.
1786. *Bayersche Reise.* Munich. 276 pp., 2 pls.
1802. *Fauna Boica.* Nűrnberg. Vol. 2, 274 and 412 pp. (Psocids: Vol. 2, pp. 191-192).

Schroder, C.
1902. See Biró, L. 1901.
1925. See Handlirsch, A. 1925.

Schubert, K.
1933. Beiträge zur Kenntnis der Thierwelt des Moosebruches im Altvategebirge (Ostsudeten). (Spinnentiere [teilweise], Insekten, Wirbeltiere). *Z. Morph. Őkol. Tiere* 26: 325-383. (Insects: pp. 334-354).

Schulze, L.
1908. See Enderlein, G. 1908b.

Schulze, P.
1936. See Weber, H. 1936.

Schumacher, F.
1917. Ueber Psociden-Feinde aus der Ordnung der Hemipteren. *Z. wiss. Insekt.Biol.* 13: 217-218.

Scopoli, J. A.
1763. *Entomologia Carniolica exhibens Insecta carnioliae indigena et distributa in ordines, genera, species, varietates, methodo Linneana.* Vindobonae. 28 and 421 pp., 43 pls.

Scott, H.
1916. Note on the swarming of chloropid flies, Psocidae, etc. in houses. *Ent. mon. Mag.* 52: 18-21. (Psocids pp. 20, 21). *Pterodela pedicularus* and *Ectopsocus briggsi.*

Scott, J.
1907. Insect agencies as a cause of larch canker. *J. Board. Agric.* 14: 551-554, 4 figs. *Caecilius flavidus.*

Scudder, S. H.
1869. See Harris, T. W. 1869.
1877. On the structure of the head of *Atropos. Psyche, Camb., Mass.* 2: 49-51. (See Burgess, E. 1877).
1890. The Fossil Insects of North America, with notes on some European species. 2 vols. New York. (Vol. I. *The Pre-Tertiary Insects,* 455 pp., 35 pls.; Vol. II. *The Tertiary Insects,* 663 pp., 28 pls.) (Psocids: Vol. II pp. 117-118, pl. 5, fig. 51). *Parapsocus disjunctus.*

Sellards, E. H.
1909. Types of Permian Insects. Part III. Megasecoptera, Oryctoblattinidae and Protorthoptera. *Amer. J. Sci.* 27: 151-173, 28 figs.

Selys-Longchamps, E. de

1872. Notes on two new genera of Psocidae. *Ent. mon. Mag.* 9: 145-146, 2 figs. *Psyllipsocus, Hemipsocus.*
1873. Révision des Psocides décrites par Rambur, suivie de la liste des espèces de cette famille observées jusqu'ici en Belgique. *Ann. Soc. ent. Belg.* 16: 1-5.
1879. La sous-famille des Psocines en Angleterre en Belgique et en Scandinavie. *C.R. ent. Belge.* 22: 164-167.
1888. Catalogue raisonné Orthoptères et des Neuroptères de Belgique. *Ann. Soc. ent. Belg.* 32: 103-203. (Psocids: pp. 125-131). Belgian spp.

Seshadri, A. R.

1953. Observations on *Trichinothrips brevipes* (Bagnall) a little known predatory thrips from South India. *Indian J. agric. Sci.* 23: 27-39, 3 pls.

Sharp, D.

1901. *In* Cambridge Natural History. London. (Psocidae: Vol. 5, 390-398, figs. 241-249). Psocids are dealt with as Psocidae within Neuroptera, in Chap. 17.

Shepard, H. H.

1939a. Insects infesting stored foods. *Bull. Minn. agric. Exp. Sta.* 340:20.
1939b. Insects infesting stored foods. *Bull. Minn. agric. Exp. Sta.* 341:27.
1955. See Fernald, R. T. and Shepard, H. H. 1955.

Sherborn, C. D.

1902. *Index animalium, sive Index nominum que ab. AD MDCCLVIII generibus et specibus animalium imposita sunt. Sectio prima, a Kalendis Janueris MDCCLVIII usque ad finem Decembris MDCCC.* Cambridge. i-lix, 1195 pp.
1922-33. *Index Animalium . . . sectio secunda a kalendis Ianuariis, MDCCCI usque ad finem Decembris, MDCCCI.* London, 9 vols.

Shimer, H.

1870. Book worms. *Amer. Ent.* 2: 322-324, 2 figs. (Psocids: p. 324, in editorial note). Damage to books, *Atropos* or *Clothilla.*

Shipley, A. E.

1904. The Orders of Insects. *Zool. Anz.* 27: 259-262.

Shiraki, T.

1952. *Catalogue of injurious insects in Japan (exclusive of animal parasites).* Tokyo. *Econ. Sci. Sect. nat. Res. Div. Prelim. Study* No. 71. 7 vols. (Corrodentia: Vol. 2, p. 16).

Siebold, C. T.

1851. Beiträge zur Fauna der wirbellosen Thiere der Provinz Preussen. *Neue preussische Prov. Blätt. Königsberg* 11: 351-358. (Corrodentia: p. 352).

Silvestri, F.

1934. *Compendio di entomologia applicata (Agraria-Forestale-Medica-Veterinaria).* Portici. Parte speciale 1: 1-448, 414 figs. (Corrodentia: pp. 162-171).

Singh, B.

1953. See Roonwal, M. L. et al. 1953.

Sinha, R. N.

1961. Insects and mites associated with hot spots in farm stored grain. *Canad. Ent.* 93 (8): 609-621. *Liposcelis bostrychophilus.*

Smith, F.

1866. (Notice in minutes). *Proc. ent. Soc. Lond.* 5: lxxiv. Ticking sound.
1867. Notes on *Anobium tessellatum*. *Ent. mon. Mag.* 3: 279. Mention of *Atropos pulsatorium*.

Smith, M. R.

1928. The biology of *Tapinoma sessile* Say, an important house-infesting ant. *Ann. ent. Soc. Amer.* 21: 307-329, 5 figs., pl. XVIII. (Psocid: p. 323). Psocid in nests in laboratory thought to be *Troctes divinatorius* (Müller)

Smith, R. F.

1962. See Hurd, P. D. et al. 1962.

Smithers, C. N.

1956a. The male of *Ectopsocopsis mozambicus* (Badonnel) (Psocoptera, Peripsocidae). *Ent. mon. Mag.* 92: 306-307, 2 figs.
1956b. A new species of *Isophanes* (Caeciliidae, Psocoptera) from Natal. *J. ent. Soc. S. Afr.* 29 (1): 29-32, 4 figs.
1957a. Some new species of *Mesopsocus* (Psocoptera: Mesopsocidae) from Southern Africa. *Trans. R. ent. Soc. Lond.* 109 (7): 245-258, 15 figs.
1957b. Notes et descriptions sur les Psocoptères de Madagascar. *Nat. malgache* 9 (2): 273-280, 6 figs.
1957c. Three new species of Myopsocidae (Psocoptera) from Natal. *Proc. R. ent. Soc. London (B)* 26: 11-16, 11 figs.
1958a. A new genus and species of domestic Psocid (Psocoptera) from Southern Rhodesia. *J. ent. Soc. S. Afr.* 21 (1): 113-116, 6 figs. *Dolopteryx domestica.*
1958b. Records and descriptions of Psocoptera from Nigeria. *Ent. mon. Mag.* 94: 55-56, 4 figs.
1959. Nomenclatural note on three species of African Psocoptera. *Ent. mon. Mag.* 94: 274.
1960a. Mission zoologique de l'I.R.S.A.C. en Afrique orientale (P. Basilewsky et N. Leleup, 1957). LV. Psocoptera. *Ann. Mus. Congo belge 8vo.* 88: 365-376, 16 figs.
1960b. A collection of Psocoptera from Australian chestnut trees in Natal, South Africa. *J. ent. Soc. S. Afr.* 23 (1): 218-222. 3 figs.
1962a. New species and records of Elipsocidae from Africa (Psocoptera). *J. ent. Soc. S. Afr.* 25 (2): 255-262, 19 figs.
1962b. Insects of Macquarie Island. Psocoptera: Philotarsidae. *Pacific Ins.* 4 (4): 929-932, 6 figs.
1963a. The generic position of two species of Philotarsidae (Psocoptera). *J. ent. Soc. Qd.* 2: 60.
1963b. Two new genera of Elipsocidae (Psocoptera) from Australia. *Proc. R. ent. Soc. Lond.* (B) 32: 32-37, 12 figs.
1963c. New records of Myopsocidae (Psocoptera) from Africa with a description of the female of *Phlotodes angolensis* Bad. *J. ent. Soc. S. Afr.* 26 (1): 187-189, 2 figs.
1963d. The Elipsocidae of Australia. *Pacific Ins.* 5 (4): 885-898, 25 figs.
1963e. *Psilopsocus mimulus* sp.n. (Psocoptera: Psilopsocidae) representing a family new to Australia. *J. ent. Soc. Qd.* 2: 56-59, 10 figs.
1964a. New Records of Cave and Mine-dwelling Psocoptera in Australia. *J. ent. Soc. Qld.* 3: 85.
1964b. The Archipsocidae (Psocoptera) of Australia. *J. ent. Soc. Qd.* 3: 79-82, 11 figs.
1964c. Insects of Campbell Island. Psocoptera. *Pacific Ins. Monogr.* 7: 226-229, 7 figs.

Snodgrass, R. E.

1905. A revision of the mouthparts of the Corrodentia and the Mallophaga. *Trans. Amer. ent. Soc.* 31: 297-307, pl. viii.
1935. *Principles of Insect Morphology.* New York and London. i-x, 667 pp.
1944. The feeding apparatus of biting and sucking insects affecting man and animals. *Smithson. misc. Coll.* 104 (7): 1-113, 39 figs. (The Biting lice and Booklice. Orders Mallophaga and Corrodentia: pp. 21-30, figs. 9-11).
1957. A revised interpretation of the external reproductive organs of male insects. *Smithson. misc. Coll.* 135 (6): 1-60, illustr. (Psocoptera: p. 19).

Snyder, T. E.

1915. Biology of Termites of Eastern United States. *U.S. Bur. ent. Bull.* 94 (2): 13-83. (Psocids: p. 71).
1926. Preventing damage by *Lyctus* powder-post beetles. *Fmrs'. Bull. U.S. Dep. Agric.* 1477: 1-12. Psocids mentioned as scavengers.

Soehardjan, M.

1958. First contribution to a study of Copeognatha (Corrodentia) of the Indonesian archipelago. *Idea*: 11 (1): 25-33.

Soehardjan, M. and **Hamann,** H. H. F.

1959. Second contribution to the Indonesian Psocidfauna; notes on some recent collectings. *Idea* 12 (1): 1-13, 35 figs.

Sofner, L.

1941. Zur Entwicklungsbiologie und Ökologie der einheimischer Psocopteren Arten *Ectopsocus meridionalis* Rib. und *Ectopsocus briggsi* McL. *Zool. Jb. Abt. Syst.* 74: 323-360, 14 figs.

Solowiow, P.

1924a. Biologische Beobachtungen über Holzlaus *(Atropos pulsatoria* L.) *Zool. Anz.* 59: 238-240.
1924b. Biologische Beobachtungen über die Holzlaus *(Atropos pulsatoria* L.). *Z. wiss. Insekt.Biol.* 19: 46-48.
1924c. Neue Arten Blassenfüsse. *Ent. Z.* 38: 21-25, 1 fig.
1925. Biologische Beobachtungen über Holzlaüse *(Atropos pulsatoria* L.). *Zool. Jb. Abt. Syst.* 50: 270-272.

Sommerman, K. M.

1942. Rearing Technique for Corrodentia. *Ent. News* 53: 259-261, 1 fig.
1943a. Bionomics of *Lachesilla nubilis* (Aaron) (Corrodentia Caeciliidae). *Canad. Ent.* 75: 99-105.
1943b. Description and bionomics of *Caecilius manteri* n.sp. (Corrodentia). *Proc. ent. Soc. Wash.* 45 (2): 29-39, 15 figs.
1943c. Bionomics of *Ectopsocus pumilis* (Banks) (Corrodentia, Caeciliidae). *Psyche, Camb., Mass.* 50 (3/4): 53-64, 2 pls.
1944. Bionomics of *Amapsocus amabilis* (Walsh) (Corrodentia, Psocidae). *Ann. ent. Soc. Amer.* 37 (3): 359-364, 1 pl.
1946. A revision of the genus *Lachesilla* north of Mexico (Corrodentia Caeciliidae). *Ann. ent. Soc. Amer.* 39 (4): 627-661, 4 pls.
1948. Two new Nearctic Psocids of the Genus *Trichadenotecnum* with a nomenclatural note on a third species (Corrodentia). *Proc. ent. Soc. Wash.* 50 (7): 165-173, 1 pl.
1956a. Two new species of *Rhyopsocus* (Psocoptera) from the U.S.A., with notes on the bionomics of one household species. *J. Wash. Acad. Sci.* 46 (5): 145-149, 17 figs.
1956b. Parasitization of nymphal and adult psocids (Psocoptera). *Proc. ent. Soc. Wash.* 58 (3): 149-152. North American spp.

1957. Three new species of *Liposcelis (=Troctes)* (Psocoptera) from Texas. *Proc. ent. Soc. Wash.* 59 (3): 125-129, 7 figs.

Sommerman, K. M. and **Pearman,** J. V.

1955. *In*: A Century of Progress in the Natural Sciences, 1853-1953. California Academy of Sciences. (Psocoptera [Corrodentia, Copeognatha]: pp. 523-525).

Southcott, R. V.

1941. See Womersley, H. and Southcott, R. V. 1941.

Spangberg, J.

1878. Psocina Sueciae et Fenniae. Őfversigt af Sveriges och Finlands Psociner. *Oefv. Ak. Forh.* 2: 5-29, pls. I, II. 18 spp. listed. (Ref. Kolbe, H. 1880c).

1880. Sur quelques espèces européens de la sousfamille des Psocines. *Ent. Tidskr.* 1 (2): 94-98, pl. 1, figs. 4-6. *Stenopsocus striatulus* (Fabr.), *Psocus morio* Latr., *Psocus subnebulosus* Steph.

Spruyt, F. J.

1927. Notes on *Alaptus psocidivorus* Gahan, a new species of Mymaridae (Hymenoptera). *Pan-Pacif. Ent.* 3 (4): 182-184, 12 figs.

Stackhouse, H.

1724. An account of the Scarabeus galeatus pulsator or the Death-Watch. *Phil. Trans.* 33 (385): 159-162.

Stager, R.

1917. *Stenopsocus stigmaticus* (Imh. & Labr.) und sein Erbfeind. *Z. wiss. Insket.Biol.* 13 (3/4): 59-63, 2 figs.

Stains, G. S.

1941. See Knowlton, G. F. and Stains, G. S. 1941.

Stephens, F.

1829. *A systematic catalogue of British Insects*: *being an attempt to arrange all the hitherto discovered indigenous insects in accordance with their natural affinities.* London. i-xx, 388 pp. (Psocidae: pp. 312-314).

1836. *Illustrations of British Entomology, or Synopsis of indigenous Insects etc.* London. 1827-1846. (Psocids: Pt. 6, pp. 115-129).

Strand, E.

1916. Psociden-Gespinste aus Paraguay. *Arch. Naturgesch.* 81 (12): 135-136, 1 pl.

Strobl, G. and **Klapalek,** F.

1906. Neuropteroiden (Netzflügler) Steiermarks (und Niederősterreichs). *Graz. Mitt. Natw. Ver. Steierm.* 42: 225-266. (Psocids: pp. 255-258).

Strouhal, H.

1939. Die in den hohlen von Warmbad Villach, Karnten, festgestellten tiere. *Folia zool. hydrobiol. Riga* 9: 247-290. (Psocid: pp. 266-267). *Bertkauia lucifuga* Rambur recorded as new for Karnten.

Sulzer, J. H.

1761. *Die Kennzeichen der Insekten nach Anleitung des Kőnigl. Schwed. Ritters und Leibarzts Karl Linnaeus durche XXIV. Kupfertafeln erläutert und mit derselben natűrlichen Geschichte erläutert etc.* Zurich. (Psocid: pp. 177, 179, fig. 144d).

1776. *Abgekürzte Geschichte der Insekten nach dem Linneischen System.* Wintethur. 2 vols. Vol. 1. i-xxviii, 274 pp.; Vol. 2 72 pp., 37 pls. (Psocids: Vol. 1. pp. 173, 240; Vol. 2. pp. 48, 58, pl. XXIV, figs. 12, 13; pl. XXIX, fig. 3, 3b). The plates of this book are the same as those in Roemer, J. J. 1789.

Svadzhyan, P. K., **Vishnyakova,** V. N. and **Mardzhanyan.** K. S.

1963. On the Copeognatha of the Armenian S.S.R. and the methods of their preservation in the laboratory. *Acad. Sci. Armenian S.S.R.* 16 (9): 89-94, 2 figs.

Sweetman, H. L.

1951. See Ghani, M. A. and Sweetman, H. L. 1951.

Swezey, O. H.

1929. Notes on the Egg parasites of Insects in Hawaii. *Proc. Hawaii. ent. Soc.* 7 (2): 282-292. Mymarid parasites of Psocids p. 289.

1954. Forest Entomology in Hawaii. An annotated checklist of the insect faunas of the various components of the Hawaiian forests. *Bernice P. Bishop Mus. Spec. Pub.* 44: 1-266, illustr.

Swezey, O. H. and **Bryan,** E. H.

1929. Further notes on forest insects of Molokai. *Proc. Hawaii. ent. Soc.* 7 (2): 293-314. (Corrodentia: p. 305). 2 determined spp. listed; 3 or 4 reported.

Swezey, O. H. and **Williams,** F. X.

1932. Some observations on forest insects at the Nauhi nursery and vicinity on Hawaii. *Proc. Hawaii. ent. Soc.* 8 (1): 179-190. (Corrodentia: p. 190). 7 spp. listed.

Symmons, S.

1952. Comparative anatomy of the Mallophagan head. *Trans. zool. Soc. Lond.* 27 (4): 349-436, 60 figs.

Szilady, Z.

1912. Magyarországi rovargyűjtésem jegyzéke. II. Neuroptera et Pseudoneuroptera. *Rovart. Lapok.* 19: 53-58.

Szulczeski, J. W.

1939. Verzeichniss der in der Wojewodschaft Poznán festgestellten Corrodentien. *Polsk. Pismo ent. Lwow* 16-17 (1937-1938): 90-93. (In Polish with German summary).

Tada, S.

1956. Studies on the Japanese psocid insects as stored products pest I. *Jap. J. San. Zool.* 7 (3/4): 195-202, 12 figs. (In Japanese with English summary).

1959. Studies on the Japanese psocid insects as stored products pest II. *Jap. J. San. Zool.* 10 (1): 35-40, 11 figs. (In Japanese with English summary).

1962. Studies on the Japanese psocid species as stored products pest, III. *Jap. J. San. Zool.* 13: 99-104, 12 figs. (In Japanese with English summary).

Takahashi, R.

1921. On the oecology of the Corrodentia. *Dobuts. Z., Tokyo* 33: 173-180, 2 figs. (In Japanese). An abstract of this paper appeared in *Jap. J. Zool.* 1 (22): 8 (1922) by Kaburaki, T.

1938. Notes on some Psocoptera of Formosa. *Mushi* 11 (1): 11-15, 2 figs. *Stenopsocus makii* sp.n. from Hori, Formosa, allied to *formosanus* Banks; 8 spp. mentioned.

Tarbinskii, S. P.

1948. See Rimsky-Korsakov, M. 1948.

Taylor, L. R.

1960. The distribution of insects at low levels in the air. *J. Anim. Ecol.* 29: 45-63.

Tetens, H.

1891. Zur Kenntnis der deutschen Psociden. *Ent. Nachr.* 17: 369-384.

Thornton, I. W. B.

1955. See Broadhead, E. and Thornton, I. W. B. 1955.

1957. Faunal succession in umbels of *Cyperus papyrus* L. on the Upper White Nile. *Proc. R. ent. Soc. Lond. (A).* 32 (7-9): 119-131, 3 figs.

1959a. A new genus of Philotarsidae (Corrodentia) and new species of this and related families from Hong Kong. *Trans. R. ent. Soc. Lond.* 111 (11): 331-349, 20 figs.

1959b. New species of *Peripsocus* Hagen 1866 (Corrodentia: Peripsocidae) from Hong Kong Island, with further descriptions of *Peripsocus similis* Enderlein 1903 and *Peripsocus quercicola* Enderlein 1906. *Proc. R. ent. Soc. Lond. (B)* 28 (3/4): 37-48, 18 figs.

1960. New Psocidae and an aberrant new Myopsocid (Psocoptera) from Hong Kong. *Trans. R. ent. Soc. Lond.* 112 (10): 239-261, 47 figs.

1961a. Comments on the geographical distribution of *Pseudocaecilius elutus* Enderlein (Psocoptera) and descriptions of related new species from Hong Kong. *Proc. R. ent. Soc. Lond. (B)* 30 (11/12): 141-152, 19 figs.

1961b. The *Trichadenotecnum* group (Psocoptera: Psocidae) in Hong Kong with descriptions of new species. *Trans. R. ent. Soc. Lond.* 113 (1): 1-24, 40 figs.

1962a. Psocids (Psocoptera) from the Batu Caves, Malaya. *Pacific Ins.* 4 (2): 441-455, 30 figs. Psyllipsocidae, Lepidopsocidae, Peripsocidae.

1962b. The Peripsocidae (Psocoptera) of Hong Kong. *Trans. R. ent. Soc. Lond.* 114 (9): 285-315, 48 figs.

1962c. Note on the genitalia of two New Zealand Philotarsids (Insecta: Psocoptera). *N.Z.J. Sci.* 5 (2): 241-245, 8 figs.

Thornton, I. W. B. and **Broadhead,** E.

1954. The British species of *Elipsocus* Hagen (Corrodentia, Mesopsocidae) *J. Soc. Brit. Ent.* 5 (2): 47-64, 16 figs.

Tillyard, R. J.

1918. On the affinities of two interesting fossil insects from the upper Carboniferous of Commentry, France. *Proc. Linn. Soc. N.S.W.* 43 (1): 123-134, 3 figs.

1921. Two fossil insect wings in the collection of Mr. John Mitchell from the Upper Permian of Newcastle, N.S.W. belonging to the order Hemiptera. *Proc. Linn. Soc. N.S.W.* 46 (4): 413-422, 5 figs, pl. XXXV.

1923. A Monograph of the Psocoptera, or Copeognatha, of New Zealand. *Trans. N.Z. Inst.* 54: 170-196, 20 figs., pl. 18.

1926a. *The insects of Australia and New Zealand.* Sydney. pp. i-xiv, 560, figs. A1-ZB4, Pls. 1-44. (Copeognatha pp. 126-130, figs. N1-N2, pl. 2, figs. 6-7; pl. 11, fig. 6).

1926b. Kansas Permian Insects. 8: The Order Copeognatha. *Amer. J. Sci.* 11: 315-349, 19 figs.

1928. Kansas Permian Insects. 12. The family Delopteridae, with a discussion of its ordinal position. *Amer. J. Sci.* 16: 469-484.

1935. Upper Permian insects of New South Wales III. The Order Copeognatha. *Proc. Linn. Soc. N.S.W.* 60: 265-279, 13 figs. Lophioneuridae removed from Homoptera and put into Copeognatha; Carpenter's family Cyphoneuridae merged with Lophioneuridae; keys to families, genera, species; new genera and species.

1937. Kansas Permian Insects. *Amer. J. Sci.* 33: 81-110.

Titschack, E.

1930. Die Copeognatha, Megaloptera, Neuroptera, und Mecoptera der nahteren und weiteren Umgebung Hamburgs. *Verh. Ver. naturw. Unterh. (Heimatforsch) Hamb.* 21: 104-127. (Copeognatha pp. 108-113).

Torne, H. von

1940. Staubläuse als Getreideschadlinge und ihre Bekämpfung durch die Delicia-Kornkaferbegasung. *Z. hyg. Zool.* 32: 207-218, 4 figs.

Townes, H. K.

1951. See Muesebeck, C. F. W., Krombein, K. V. and Townes, H. K. 1951.

Townsend, Ch. H. T.

1912. Vulturopinae, a new Subfamily of the Psocidae; type Vulturops gen. nov. (Platyp., Corrod.). *Ent. News* 23: 266-269, 3 figs.

Toxopeus, L. J.

1939. Entomologische notities uit Nieuw-Guinea. *Ent. Med. Ned. Ind.* 5: 11-17, 24-37, 59-71, 5 pls. (Psocoptera: pp. 28, 33). Mentions collections of Psocids from New Guinea, but specimens now lost. See Soehardjan, M. 1958.

Tragardh, I.

1909. Orthoptères, Pseudonevroptères. In Bey, I. Résumé de travaux relatifs en partie à la faune entomologique de l'Egypte. *Bull. Soc. ent. Egypte* 1 (1909 [1]): 10-23. (Orthoptères, Pseudo-Nevroptères: p. 17). Mentions 2 spp. as having been already described by Enderlein, G. (cf. Enderlein, G. 1905).

Tsutsumi, Chisato.

1961. Notes on the Psocoptera of Japan. 1. On the familial character of a psocid species, *Matsumuraiella radiopicta* Enderlein (Psocidae). *Kontyû* 29: 56-61, 2 figs. (In Japanese with English summary).

1962. Studies on the domiciliary psocids of Japan. (I). *Jap. J. San. Zool.* 13 (3): 190-196, 16 figs. (In Japanese with English summary). Characters and life histories of *Trogium pulsatorium, Lepinotus reticulatus, Tapinella africana* in Japan.

1964. New species and records of Psocoptera from the Amani Islands, Japan. *Kontyû* 32 (1): 117-212, 2 figs.

Tullgren, A.

1909. Bidrag till kännedom om Sveriges Copeognather. *Ark. Zool.* 5 (8): 1-15, 2 figs.

1922. *Lepinotus inquilinus* Heyd. funnen i Sverige. *Ent. Tidskr.* 43: 71.

Tumpel, R.

1922. *Die Geradflüger Mitteleuropas.* 2. Aufl. Gotha. 325 pp., 94 figs., 23 pls. (Pseudoneuroptera Corrodentia: pp. 142-157, figs. 50-58, pl. XXIII.).

Tuxen, S. L.
1956. See Badonnel, A. 1956.

Ulyanin, V.
1896. List of the Neuropterous and Orthopterous insects of the Province of the Moscow district of Studies. *Report of the Society of Amateurs of Natural Science, Anthropology and Ethnography.* 6 (2): 20-22.

Ulmer, G.
1927. See Enderlein, G. 1927.

Usinger, R. L.
1963. See Butler, G. D. and Usinger, R. L. 1963.

Vachon, M.
1932. Recherches sur la biologie des Pseudoscorpionides. 1e note. La nutrition chez *Chelifer cancroides* L. *Bull. sci. Bourgoyne* 2: 21-26, 7 figs. Psocids as prey.

Vandel, A.
1964. *Biospeologie. La biologie des Animaux cavernicole.* Paris. i-xviii, 619 pp., 11 pls. (Psocoptera: p. 220).

Verdier, P. H.
1949. See Quezel, P. et al. 1949.

Verrill, A. E.
1902. The Bermuda Islands, their scenery, climate, production, physiography, natural history and geology. *Trans. Conn. Acad. Arts Sci.* 11: 413-957, figs. 1-246, pls. lxv-civ. (Psocids: pp. 817-819, figs. 192, 192a, 192b.)

Villers, C. J. de
1789. *Caroli Linnaei entomologica, faunae suecicae descriptionibus aucta.* Lugduni. 4 vols. (Psocids: vol. 3, pp. 49-54).

Vishnyakova, V. N.
1959a. Towards the morphology of the sex system of Psocids (Psocoptera). *Acad. Sci. USSR All-Union Ent. Soc. 4th Congress. Theses of papers I. General, Med. and Vet. Ent.* pp. 33-35. (In Russian).
1959b. On the fauna and ecology of Psocoptera of Moscow and Ryazan regions of the U.S.S.R. *Rev. Ent. U.R.S.S.* 38 (2): 435-442. (In Russian with English summary). (An English summary of this paper appeared in *Ent. Review* 38: 388-394, 1960).
1962. See Becker-Migdisova, E. E. and Vishnyakova, V. N. 1962.
1963. See Svadzhyan, P. K., Vishnyakova, V. N. and Mardzhanyan, K. S. 1963.
1964. *In*: Bey-Bienko, G. Ya (Ed.). Keys to the insects of the European part of the U.S.S.R. I. *Keys to the Fauna of U.S.S.R., Moscow* 54: 1-935, 344 figs. (Psocoptera: pp. 291-308, figs. 149-154). (In Russian).

Vollenhoven, S. C. von
1861. *De dieren von Nederland — Gelede dieren.* Harlem.

Wachter, S.
1925. The hatching of the eggs of *Peripsocus californicus* Banks. *Pan-Pacif. Ent.* 2 (2): 87-89.

Walkenaer, C. A. de

1802. *Faune Parisienne. Histoire abrégée des insectes des environs de Paris, etc.* Paris. 2 vols.

Walker, F.

1853. *Catalogue of the specimens of Neuropterous insects in the collection of the British Museum. London.* (Psocids: Part 3, pp. 477-501).
1860. Characters of undescribed Neuroptera in collection of W. W. Saunders, Esq., F.R.S. etc. *Trans. ent. Soc. Lond. ser. 2,* 5: 176-199. (Psocids: p. 198). *Psocus reponens.*

Walloff, N.

1958. See Richards, O. W. and Walloff, N. 1958.

Walsh, B. D.

1862. List of the Pseudoneuroptera of Illinois contained in the cabinet of the writer. *Proc. Acad. nat. Sci. Philad.* 14: 361-402. (Psocids: pp. 361-362).
1863. Notes. *Proc. ent. Soc. Philad.* 2: 182-186. (Notes on Hagen, H. 1863, see p. 186). Notes by B. D. Walsh to paper by Hagen, H. 1863.
1867. On the insects, Coleopterous, Hymenopterous and Dipterous, inhabiting the galls of certain species of willow. Part 2 and last. *Proc. ent. Soc. Philad.* 6: 223-288. (Psocid: p. 270). *Psocus rufus* bred from Cecidomyid gall.

Wapshere, A. J.

1960. See Broadhead, E. and Wapshere, A. J. 1960.

Waterton, J.

1904. Trichoptera and Neuroptera from Arran. *Ann. Scot. nat. Hist.* 1904: 194. *Elipsocus westwoodi* and *E. abietis* listed.

Weber, H.

1931. Die Lebensgeschichte von *Ectopsocus parvulus* (Kolbe 1882). Ein Beitrag zur Kenntnis der einheimischen Copeognathen. *Z. wiss. Zool.* 138: 457-486, 18 figs.
1933. *Lehrbuch der Entomologie.* Jena. xii, 726 pp., 555 figs.
1936. Copeognatha. *In* Schulze, P. *Biologie der Tiere Deutschlands.* Berlin. (Copeognatha: Lief 39, Teil 27, pp. 27. 1-27. 50, 27 figs.).
1938. Beiträge zur Kenntnis der Ueberordnung Psocoidea. 1. Die Labialdrüsen der Copeognathen. *Zool. Jb. Abt. Anat.* 64: 243-286, 16 figs. Anatomy and function of labial glands.

Weber, N. A.

1959. See Gressitt, J. L. and Weber, N. A. 1959.

Weber, S. E.

1906. The Possible Dissemination of Tubercle Bacilli by Insects. *N.Y. med. J.* 84: 884-888, 4 figs.
1907. A new Genus of Atropidae. *Ent. News.* 18: 189-194, 5 figs. *Ocellataria,* North America.

Websdale, G. R.

1884. The death watch and its sound. *Entomologist* 17: 236-237. *Atropos pulsatorius* making ticking sound.

Weele, H. W. van der
1906. Lijst van Neuropteroidea, gevonden bij Oldenzaal en Denekamp, ter gelegenheid van de Zomervergadering der Ned. Ent. Ver. Juli 1906. *Ent. Ber., Amst.* 2: 146-147. (Corrodentia: p. 146). 8 spp. listed.
1907. Eerste supplement op den Catalogus der Nederlandsche Neuropteroiden. *Tijdschr. Ent.* 50: 121-128. (Corrodentia: pp. 122-123). 14 spp. listed.

Wei, H.
1953. See Chou, M., Chung, C. and Wei, H. 1953.

Weidner, H.
1949. Psocoidea. *Handb. Pflkranh.* 4 (1): 373-374, figs. 198-199.
1952. Die Insekten der "Kulturwűste" (Vorarbeiten zu eine Őkologie der Grossstadt). *Mitt. hamburg. zool. Mus.* 51: 89-173. 8 spp. listed.

Weiss, H. B. and **Carruthers,** R. H.
1936. The more important insect enemies of books and a bibliography of the literature. *Bull. N.Y. Publ. Libr.* 40 (9-12): 739-752, 827-841, 985-995, 1049-1064, figs. (Psocids: pp. 742-743).
1937. *Insect enemies of books.* New York 63 pp., 4 pls.

Weiss, V.
1959. Die Copeognathen-Sammlung von Herrn Eduard Feldtmann. *Bombus* 2 (16/17): 62-64. List.

Werner, F.
1928. See Zerny, H. 1928.

Westwood, J. O.
1840a. *Synopsis of the genera of British Insects.* London. 158 pp. Bound with Vol. II of Westwood, J. O. 1840b. and often referred to as an appendix to that work. Date often given as 1839 but as the genus *Lachesilla*, established on p. 47, is referred to in Vol. II: 20 of Westwood, J. O. 1840, it shows that it was not then printed which would preclude the date 1839. (Psocidae: pp. 46-47, 158).
1840b. *An introduction to the modern classification of Insects founded on the natural habits and corresponding organisation of the different families.* London. 2 vols. Vol. I (1839), i-xiii, 462 pp., figs. 1-56, 1 pl. Vol. II (1840), i-xi, 587 pp., figs. 57-133. (Psocidae: Vol. II: 17-20, fig. 59).
1841 Observations on the Structural Characters of the Deathwatch, with the Description of a new British Genus belonging to the family Psocidae. *Ann. Mag. nat. Hist.* 6: 480. *Clothilla.*
1845. Observations upon the structural character of the Death Watch *(Atropos pulsatoria)* with Description of a new British Genus in the family to which it belongs. *Trans. ent. Soc. Lond.* 4: 71-72. *Clothilla studiosa.*

Whitehead, W. E.
1933. Parasites from a Bird's nest. *J. econ. Ent.* 26: 292-293.

Wierzejski, A.
1883. Dodatek do fauny sieciówek (Neuroptera). *Spraw. Kom. fizjogr., Kraków* 17: 235-255.

Williams, F. X.
1931a. Hawaiian Psocidae. *Proc. Hawaii. ent. Soc.* 7 (3): 371-372. 6 spp. mentioned as new, described in Banks, N. 1931a.

1931b. *Handbook of the insects and other invertebrates of Hawaiian sugar cane fields.* Honolulu.
1932a. See Swezey, O. H. and Williams, F. X. 1932.
1932b. Two immigrant Psocidae in Hawaii. *Proc. Hawaii. ent. Soc.* 8: 8. *Psocus lachlani* Rib., *Psoquilla marginepunctata* Hag.

Williner, G. J.
1943a. Los Psocópteros de Mar del Plata. *Rev. Soc. ent. argent* 11: 471-480, pl. XXI.
1943b. Psocópteros de misiones generos y especies nuevos. *Rev. Soc. ent. argent.* 12: 109-121, 1 pl.
1944a. Un Psocoptero critico. *Rev. Soc. ent. argent* 12 (4): 41-44, 3 figs.
1944b. Un *Lichenomima* argentino (Corrodentia, Myopsocidae). *An. Soc. cient. argent.* 138: 158-161, 1 fig.
1944c. Caecilidos nuevos (Corrodentia: Caecilidae). *Acta zool. lilloana* 2: 293-299, 3 figs.
1944d. Dos nuevos Corrodéntidos de Córdoba. *Notas Mus. la Plata (Zool.)* 9: 445-451, 3 figs.
1945. Cinco especies nuevas misioneras del genéro *Psocus* (Corrod. Psoc.). *Rev. Soc. ent. argent.* 12: 235-243, pl. XVIII.
1946. Corrodéntidos del Brasil (Corrodentia: Psocidae et Caeciliidae). *Acta zool. lilloana* 3: 231-234, 1 pl.
1949. Corrodentios de Bolivia. *Rev. Inst. Invest. Mus. argent. Cienc. nat.* 1: 95-126, 15 figs.

Wlodarczyk, J.
1960. Psocoptera in the parks of Lodź. *Fragm. faun. Warsaw* 8: 469-483, 5 figs. (In Polish with English and Russian summaries). 5 spp. not previously recorded from Poland, 26 spp. listed.
1963. Psocoptera of some bird nests. *Fragm. faun. Warsaw* 10: 361-366, 3 figs. (In Polish with Russian and English summaries). 8 spp. listed; 5 spp. new to Poland.

Wolcott, G. N.
1923. Insectae Portoricensis, a preliminary list of the insects of Puerto Rico, with descriptions of some new species. *J. Dep. agric. P.R.* 8: 33. 3 spp. listed.
1936. Insectae Borinquensis, a revised list of the insects of Porto Rico. *J. Agric. Univ. P.R.* 20: 51-52. 13 spp. listed.
1950. The Insects of Puerto Rico. *J. Agric. Univ. P.R.* 32: 1-224. (Corrodentia: pp. 74-76).

Wolf, B.
1934. *Animalium Cavernarum Catalogus. Berlin.* (Part 3: 145-224).

Wolter, H.
1927. En főr faunan ny psocid, *Lepinotus formicarius* Hag. *Mem. Soc. Fauna Flor. fenn.* 4: 30.

Womersley, H.
1937. Miscellaneous Insecta — Psocoptera. *B.A.N.Z.A.R.E. Rep. Ser. B,* 4 (3): 81. Mentions *Clothilla pulsatoria* from American Bay, Possession Is., Crozets, and one on ship at Kerguelen.

Womersley, H. and **Southcott,** R. V.
1941. Notes on the Smarididae (Acarina) of Australia and New Zealand. *Trans. R. Soc. S. Aust.* 65: 61-78, 8 figs. *Smaris prominens* on *Liposcelis divinatorius.*

Woodroffe, G. E.
1953. An ecological study of the Insects and Mites in the nests of certain birds in Britain. *Bull. ent. Res.* 44: 739-772, 2 figs. 3 pls.

Wundrig, G.
1936. Die Sehorgane der Mallophagen, nebst vergleichenden Untersuchungen an Liposceliden und Anopluren. *Zool. Jb. Abt. Anat.* 62: 45-110, 64 figs.

Yosumatsu, K.
1938. See Esaki, T., Hori, H. and Yosumatsu, K. 1938.

Zalessky, G. M.
1937a. Sur un representant d'un nouvel ordre d'insectes permiens. *Ann. Soc. géol. Nord.* 61: 50-71, 6 figs. Includes fossil Hemipsocoptera; discussion on Permopsocidae.
1937b. Ancestors of some groups of the present day Insects. *Nature, Lond.* 140: 847-848, 3 figs. (Psocid: p. 847, fig. 2). *Maueria* and *Parapsocidium*.
1939. Etudes des insectes permiens du basin de la Sylva et problèmes de l'évolution dans la classe des insectes. III. *Probl. Paleont. Moscow* 5: 33-91, 3 pls., 45 figs. (In Russian with French summary). (Psocids: pp. 45-49, figs. 19, 24, pl. 1, fig. 4).

Zalessky, M. D.
1929. Sur les nouveaux Insectes du Permien des bassins des fleuves la Kama, la Viatka et la Belaia. *Trans. Natur. Soc. Univ. Kazan.* 70 (1): 1-30, figs. (Psocids: p. 17, fig. 6). Deals with fossil psocids including *Idelopsocus*.
1932. Observations sur les nouveaux Insectes permiens de l'Europe Orientale. *Bull. Soc. géol. Fr.* (5) 2: 183-210, 12 figs., 3 pls. (Psocids: pp. 190-192, fig. 5, pl. 12, fig. 1).

Zavarzin, A.
1906. Beiträge zur Copeognathen-Fauna der Provinz Novgorod (Nord Russland). *Ber. Susswasserst. Naturf. Ges. St. Petersburg* 2: 271-276.

Zerny, H.
1928. Neuroptera. *In* Werner, F. Beiträge zur Kenntnis der Fauna Griechenlands, namentlich der agäischen Inseln. *S.B. Akad. Wiss., Wien* (I) 137: 283-295, 9 figs.

Zetterstedt, J. W.
1840. *Insecta Lapponica descripta.* Lipsiae. 1839-1840. (Psocids: Sectio 5: 1053-1056).

Zimmerman, E. C.
1948. *Insects of Hawaii.* Honolulu. (Corrodentia: Vol. 2, pp. 217-255, figs. 121-137). General account of the order in Hawaii.
1957. *Insects of Hawaii.* Honolulu. (Corrodentia: Vol. 6, p. 179).

BOOK REVIEW

AUSTRALIAN SPIDERS—John Child—Periwinkle Press, Gladesville, New South Wales—i-vi, 87 pp., 35 figs., pl. I-XVII (VIII, XV col.), 1965. 7/6.

This small introductory book is an addition to the semi-popular literature on Australian spiders.

Chapter 1 contains a very brief explanation of the use of scientific names, with particular reference to Arachnids. It is unfortunate that the wording infers that *Araneus* is of family rank, although subsequently the group is correctly referred to as a genus. Chapter II is a brief description of the anatomy of the spider with explanation of terms which are used subsequently in the book; there are simple but effective illustrations to aid in understanding these. An additional help to those not familiar with technical terms are indications of pronunciation of some of the words (e.g. "chelicerae (kee-LISS-er-ee)"). Chapter III deals even more briefly, in a similar manner, with internal structures and such matters as courtship, eggs and mating receive mention. Chapters IV-XIII deal with the main families of spiders in Australia; the common genera are mentioned, each under a bold type heading; in most cases one or two species are singled out for mention. Chapter XIV briefly mentions other Arachnid groups. A short appendix, mainly of "Further Reading," and indices complete the work.

Covering such a wide range of topics relating to a large group of organisms in such a small space leads to rigid selection and extreme condensation of material. One of the dangers in this process is loss of accuracy but this has been admirably avoided. The line illustrations are useful and although many lack the detail which could have been included they do provide an accurate impression of the spider's appearance; this is, in fact, often of more value to the beginner than more complex illustration. A few of the black and white plates have been a little too obviously retouched.

This contribution forms an excellent first introduction to the spiders for the young naturalist and generally interested layman. Bush walkers will also find in it some useful background information although they are more likely to encounter species belonging to groups not mentioned than is the suburban reader. It is technical enough to be clear in meaning but easy to understand. The "Further Reading" list will guide those interested in going a little deeper into matters.

The book is well produced, the printing is clear and on good paper, the illustrations are appropriate and well placed in relation to text; the use of clear headings and bold type makes reference easy. The size, 7" x 5", is convenient; the cover is attractive, as is the price.

C. N. SMITHERS

AN UNUSUAL ABERRATION OF **DELIAS AGANIPPE**

(Lepidoptera: Pieridae)

By J. V. PETERS

I have in my collection a male specimen of *Delias aganippe* Donovan, 1805, which has the areas of yellow scales on the underside replaced by bright red scales. The upperside is light brown instead of the normal grey to black

The specimen was collected at Northmead, N.S.W., during February, 1961 by M. Gregg.

Reference

Waterhouse, G. A., 1932, "What Butterfly is That?" Sydney.

BOOK REVIEW

SPIDERS OF AUSTRALIA—Barbara York Main—Jacaranda Press.
124 pp., illustrated, 1964—Price 14/6

This little book is a welcome addition to the well established Jacaranda Pocket Guide series. The 124 pages are well packed with information and the available space has been very economically used as a result of which the acknowledgments and references appear at the front of the book.

After a brief introduction and useful glossary an outline guide to identification is provided using habitat, webs and habits as characters.

The remainder of the book is arranged systematically with the family as the unit of identification and keys to the families are provided, using morphological features. Under each family selected genera and species are described and illustrated; biological information is also provided. An index to common names is to be found inside the back cover. An index to scientific names would have been a useful inclusion.

This book will undoubtedly be the means of introducing many people to the spiders and of popularising a group which is generally not popular with laymen. There are, as the author herself points out, differences of opinion amongst specialists; these serve only to shew the gaps in our knowledge and it is to be hoped that some of those who are "introduced" to the spiders by this book will be sufficiently encourgad by her help to make some contribution towards filling the gaps. The illustrations are clear and appropriate and the fact that they are not referred to in the text is no disadvantage as they are well placed.

The necessary general introduction to and explanation of terms has been very skilfully presented in a small space by means of illustration and the glossary.

Bibliographers and taxonomists may not be pleased with name changes in an undated work (published 15th September, 1964) of a semi-popular nature.

This book fills a real gap in the literature on Australian spiders and will be of use to all naturalists.

The work is well set out within the space available, the size and cover make it suitable for carrying in the field and the binding is adequate, allowing the book to be opened flat without risk of damage.

C. N. SMITHERS

ON AN AUSTRALIAN SPECIES OF THE EARTHWORM GENUS **MEGASCOLEX** TEMPLETON, 1844

By G. E. Gates

Two small Australian collections contained earthworms that appeared externally to be referable to *Pheretima.* On dissection, the specimens were found to belong to another genus. As opportunity for further study of *Megascolex* is unlikely, the following account is submitted primarily to call attention to a species that may have a regenerative capacity of more than ordinary interest.

Miss Elisabeth Pope very kindly secured and forwarded the collections in response to a request for material of Australian lumbricids.

Megascolex newcombei

1887. *Perichaeta newcombei* Beddard, Proc. Roy. Soc. Edinburgh, 14; 170. (Type locality, Queensland. Types, none).
1895. *Megascolex newcombei,* Beddard, A Monogr. of the Order of Oligochaeta, Oxford, p. 378.
1900. *Megascolex newcombei,* Michaelsen, Das Tierreich, Berlin, 10, p. 226.
1903. *Megascolex laingii* Benham, Trans. New Zealand Inst. 35; 273. (Type locality, Norfolk I. Types, none).
1959. *Megascolex laingii,* Lee, New Zealand Dept. Sci. Indust. Res. Bull. 130, p. 283.

New South Wales

Northbridge, Sydney, suburban garden, November 26, 1961, 1-4-11. E. Pope.
Mt. Keira, Wollongong, private garden surrounded by bush, March 11, 1962, 4-1-3. J. Walsh per E. Pope.

External characteristics. Length, to 80 mm. (some specimens softened). Diameter, 3-3½ mm. Segments, 83 (posterior amputee?), 92, 93, 96 (3 specimens), 97 (2), 98, 103, 105. Body shape, transversely and shortly elliptical in cross section behind the clitellum. Colour, reddish, in dorsum only, in the prostomium present only in the tongue portion. Prostomium, epilobous, tongue open (all). Setae, in circles from ii, with or without an obvious gap at mV and mD, 32/xii, 32/xx, *ca.* 30 posteriorly, viii/4, xviii/0 (one specimen), the maximum counted in preclitellar segments 40, in postclitellar segments 35. First dorsal pore, at 4/5 (2), ?5/6 (3), 5/6 (10), 6/7 (1). Nephropores, microscopic, unrecognizable externally, in rather unsatisfactory preparations of the cuticle seemingly in the setal circle. Clitellum, annular, yellowish, setae retained at least in part in each segment, dorsal pores occluded only at maximal tumescence, intersegmental furrows still distinguishable at maximal tumescence, xiv-xvi. Slight yellowing sometimes is recognizable in a post-setal portion of xiii.

Spermathecal pores, very small but somewhat larger than the female pores, transversely slit-like, margins sometimes slightly tumescent, less than 1/3 C apart, about in *BC*, at 7/8-8/9. Female pore, median, very slightly in front of eq/xiv. Male pores, transversely slit-like depressions at eq/xviii. The depression, as indicated by a cuticular preparation, is shallow. From the depression the cuticle is continued internally as a tube about as long as the depth of the slit and with a thickness about one third the lateromesial width of the slit. The inner end of the tube was not jagged.

Genital markings, paired almost circular areas of epidermal thickening, centred at or near *B*, presetal, in xix (6), in xix-xx (1), in xx (1), postsetal in xviii and there slightly lateral to the male pore levels (1).

Internal anatomy. Septa, present from 4/5 at least, none thickly muscular. Pigment, red, in circular muscle layer and in special longitudinal muscle band at mD.

Gizzard, rudimentary, in v. Pharyngeal glands, extending back to 7/8. Calciferous glands, lacking. Esophagus, narrow and with low, longitudinal ridges that are not lamelliform in vi-xii, wider and moniliform in xiii-xiv where irregular, non-lamelliform ridges are gorged with blood, valvular in xv. Intestinal origin, in xvi (14). Typhlosole, lacking, or if present very rudimentary and represented (one specimen) by a slight ridge recognizable only through several segments behind xxix. Caeca and supra-intestinal glands, none found and probably lacking.

Dorsal blood vessel, single throughout, complete, bifurcating under the brain, the branches uniting over the subpharyngeal ganglion to become the ventral trunk which is also complete. Supra-esophageal trunk, present in viii-xiii. Extra-esophageal trunks, median to the hearts, recognizable only back through xi. Hearts, last pair in xii (14), those in x-xii possibly latero-esophageal though connectives to the dorsal trunk were not certainly identified, hearts of ix and anteriorly lateral. Subneural trunk, none found and presumably lacking.

Excretory system, meroic, the microic tubules seemingly astomate and avesiculate. Nephridia of the clusters in iv-vi certainly are longer than the parietal nephridial of posterior segments. Nephridia behind the clitellum are in transverse rows nearly reaching mD and mV. One row apparently is present behind each septum. Another row may be present in front of the septum (peritoneum of some specimens fragmented!).

Holandric, coelomic cavities of x-xi filled with a sticky coagulum (all clitellate dissected specimens)—annular testis sacs with membranous walls if present could have been unrecognised. Seminal vesicles, with several lobes of varying sizes, in ix and xii. Prostrates, small, lobed, flattened against the parietles and rather band-like, in xvii, xviii-xix. Prostatic ducts, short, rather slender, *ca.* 1 mm. long. Sperm ducts, passing into ental ends of prostatic ducts or into the glands anterior to point of emergence of the prostatic ducts. (Penial and copulatory setae, none found).

Spermathecae, fairly large relatively, reaching at most up to level of dorsal face of gut. Duct almost confined to parietes and rather narrow. Diverticulum, from anterior face of duct at parietes, sometimes shorter than the main axis, reaching to or beyond ental end of ampulla. A slightly widened terminal portion may be marked off as a spheroidal to ellipsoidal seminal chamber or an ental widening may be more gradual so that the diverticulum is slenderly club-shaped. Ovaries, fan-shaped, with numerous egg strings that have as many as ten ova in a string, at largest reaching up to dorsal blood vessel. Ovisacs, present in xiv.

Reproduction. Spermatozoal iridescence was recognizable in spermathecae of several specimens and in fewer individuals also on male funnels. As sperm are exchanged during copulation, reproduction is assumed to be biparental.

Regeneration. Normal head regenerate, as yet with but little pigment, of 3 segments at 3/4. An early regenerate, without pigment, metameric differentiation or terminal sculpturing, at 4/5.

Tail regenerates. (1) Of 7 segments at 81/82. (2) At 67/68, with dorso-terminal anus and four segments already demarcated proximally. (3) At 60/61, of ten segments. (4) At 75/76, with ten segments already demarcated but metameric differentiation incomplete, anus terminal. Appearance suggest a previous regeneration by the same worm at 62/63. Possible tail regenerates: last 19 of 73 segments, last 13 of 86 segments, last 13 of 87 segments.

Capacity for head regeneration may be much greater than is indicated above (*cf.* Abnormality).

Variation and *abnormality*. No. 1) An extra spermatheca, in vii on left side, with pore at 6/7. No. 2) An extra spermathecae, in vii on the right side. No. 3) An extra pair of spermathecae, with pores at 6/7. A gizzard was not distinguishable in this specimen with 105 segments, a condition that can be expected if a head had been regenerated at 5/6 or 6/7. Extra spermathecae, in these three specimens may have been developed during head regeneration. No. 4) Spermathecal pores, at 6/7-9/10. Female pores, in xv-xvi. Male pores, in xix. Clitellum, in xv-xvii. Genital markings, presetal in xx. Testes, in xi-xiii. Spermatozoal iridescence, on male funnels of xi and left funnel of xiii. Coelomic cavities of xi-xiii filled with the same sort of coagulum that is present in x-xi of normal individuals. Seminal vesicles, in x, xiii (small) and xiv. Ovaries, in xiv-xv. Ovisacs, in xv-xvi. Spermathecae, in vii-x, normal except in the right side of vii and the left side of x where each spermatheca has two diverticula arising from the anterior portion of the duct at the parietes.

Doubling of testis, ovary and spermathecal segments can result from halving of mesoblastic somites (*cf*. Gates, 1958). Several specimens do have in unregenerate intestinal regions metameric abnormalities that could have arisen from halving of mesoblastic somites. However, location of male pores in xix (of No. [4] shows that the only embryonic halving that could have taken place would be of the somite at the thirteenth level. Other doublings must have arisen in some other way. Regeneration, in the genus *Perionyx* (*cf*. Gates, 1943) does result in increasing number of gonadal as well as of spermathecal segments. If then, regenerative capacity of the present species approximates that of *Perionyx*, all abnormalities mentioned above could have arisen during head regeneration rather than during embryonic development.

Ingesta. Mainly vegetable matter, but with some sand grains and an occasional pebble of quartz. Three species of *Perionyx*, known to have a high regenerative capacity, also are selective feeders, swallowing little but organic matter.

Systematics. The present specimens differ from *newcombei* as characterized by Beddard in two ways: paucity of genital markings, location of the gizzard in v instead of in vi. The first difference can have little systematic importance, because of possibility of considerable individual variation, until very much more information is available. In view of other similarities, the second difference scarcely seems to warrant specific separation at present.

Megascolex laingii is known only from the original description of two aclitellate, anterior fragments. The gizzard was in v as in the New South Wales worms. Absence of genital markings in Benham's worms may be of no systematic significance because of immaturity. Moreover, inornate individuals are now known in many species that usually do have genital markings. Some support for the identification is provided by four macerated specimens from Hamilton, New Zealand. If prostrates were racemose, as does seem probable, the specimens were not distinguishable from the New South Wales *newcombei* by any recognizable character.

Remarks. Species of *Pheretima*, *Plionogaster*, and *Megascolex* may have so much similarity in macroscopically recognizable external characters that dissections are necessary for generic identification.

References

Gates, G. E.

1943. Some further notes on regeneration in *Perionyx excavatus* E. Perrier. *Proc. Natl. Acad. Sci. India*, 13: 168-179.

1958. On homoeosis, as well as other aberrations, and their origin in an earthworm species, *Eisenia foetida* (Savigny, 1826), along with some deductions as to morphogenesis in the Lumbricidae. *American* Midland Nat., 59: 452-464.

OBITUARY

SIR VICTOR COPPLESON, Kt., M.B., Ch.M., F.R.C.S., F.R.A.C.S., F.A.C.S.

The death on May 12th 1965 of Sir Victor Coppleson deprived Australia of a most distinguished citizen whose loss will be felt in the many circles in which he was active.

Victor Marcus Coppleson was born in 1893 at Wee Waa, New South Wales. He was educated at Sydney Grammar School and in 1915 graduated in medicine from the University of Sydney. He became not only an eminent surgeon but the pioneer and director of Australian post-graduate medical education. He was a member of the Royal Zoological Society of New South Wales and of the Australian Marine Sciences Association.

As a young man, Coppleson was a footballer and swimmer, keen on the then infant sport of surfing. As a doctor, he was asked by the Surf Life Saving Association of Australia to write an article on "Shark Bite" for its Handbook. Little was on record in medical literature at the time, so Coppleson collected all available accounts of shark tragedies and incidents. The results of this study were published in the Medical Journal of Australia in 1933, revised and reviewed in later years, and incorporated in his book Shark Attack, 1958 (second ed., 1962). He studied shark attacks statistically, analysing and relating times of occurrence, localities, water temperatures and other factors. Hence he developed the hypothesis of the "rogue" shark which lurked in given areas for long periods, also his theory which he called "the shark's time-table" to account for the restricted times when attacks occurred in various latitudes. He had other original ideas on the ways wounds were inflicted on human beings by sharks and on methods for treating victims. The chapter on "Patterns of Shark Attack for the World" which Coppleson contributed to *Sharks and Survival* epitomized some of his ideas.

Coppleson in 1955 delivered the Post Graduate Oration in the Great Hall of the University of Sydney, choosing as his subject "The Life and Times of Dr. George Bennett," a great surgeon-naturalist in Sydney in the nineteenth century. George Bennett's correspondence with Richard Owen (preserved in the Royal College of Surgeons of England) was also therein dealt with by Coppleson, who obtained microfilm copies of many of these documents for the Australian Museum. Still of interest to biologists are Bennett's observations on the living Pearly Nautilus in the New Hebrides, on whales, invertebrates and other natural history subjects.

In addition to sharks, Coppleson's interests broadened to include other hazardous or noxious marine animals and he organised groups of scientific and other specialists to discuss sea-snakes, poisonous and venomous fishes and invertebrates at the First International Convention on Life Saving Techniques, held in Sydney in 1960. The scientific results were published three years later as a supplement to the Bulletin of the Post-Graduate Committee in Medicine of the University of Sydney.

The Medical Directory of Australia outlined Coppleson's remarkable career as a surgeon and a soldier (he served overseas as an officer in both World Wars). A list of Coppleson's zoological papers appeared in the *Proceedings* of the Linnean Society of New South Wales (vol. 89, 1964, p. 69). It was gratifying to all that his achievements were recognised in the New Year's Honours of 1964, when he was knighted by Her Majesty, Queen Elizabeth II.

G. P. WHITLEY

OBITUARY

Theo Athol Everitt

(Plate xi)

The death occurred at Sydney on December 6, 1964, of Theo Athol Everitt. "Sam", as he was known to his friends and associates, was born on March 10, 1910. The early part of his life was spent in the bush surroundings of Oatley, an outlying suburb of Sydney, where he developed a keen interest in natural history, with particular emphasis on the field study of birds. He was a keen walker and spent much of his leisure wandering over the rugged terrain of what is now known as the Royal National Park, south of Sydney, using as his base the zoologists' cabin, then pleasantly situated near the junction of Hacking River and Waterfall Creek.

Another interest was the Naval Reserve, from which he was called up to serve in the Royal Australian Navy as a lieutenant for the duration of the Second World War. He held various appointments, both on shore and at sea, being in Darwin during the Japanese air raids. The illness from which he suffered in the latter part of his life was attributed to a tropical infection contracted while serving in areas north of Australia.

Theo Everitt was Honorary Secretary of the Royal Zoological Society of N.S.W. from April, 1947 to April, 1951 and Secretary of its Ornithological Section during 1939-1940; also, at the same time, State Secretary of the N.S.W. Branch of the Royal Australasian Ornithologists' Union. In recent years he was a warden and member of the Parochial Council of St. John's Church, Darlinghurst, and, later, a member of the Council and Treasurer of St. Peter's Church, Walgett. In the latter town he was manager of the Rural Bank of N.S.W., subsequently transferring to Gundagai.

The very useful index of contents to volumes 1-37 of *The Emu*, journal of the Royal Australian Ornithologists' Union, published in 1939, was compiled by Mr. Everitt, who had joined the R.A.O.U. in 1933.

Mr. Everitt is survived by his wife, Eleanore, and daughter, Rosalie, to whom the sympathy of members is extended.

K. A. Hindwood.

BOOK REVIEW

Jacaranda Pocket Guides.
Marine Fishes of Australia Vol. 1 (1962)
Marine Fishes of Australia Vol. 2 (1962)
Freshwater Fishes of Australia. Revised Ed. (1964)

These three little volumes by G. P. Whitley, so handy that all three could be put into one pocket, are a far greater contribution than their size suggests. As an introduction to the rich variety of Australian fishes they are excellent. With together over 300 illustrations, a large proportion of them drawn by Mr. Whitley, any fish can be recognised at least to the family to which it belongs. Unfortunately none of the illustrations is in colour, but they the clear, and quite adequate for their purpose.

Until Australia is given a comprehensive book on all its wonderful fishes (perhaps by Mr. Whitley?) and even after that happy day, these books will do sterling service, and should be the well used possession of every angler and naturalist.

F. H. Talbot.

"Sydney" Painting No. 4
Spotted Quail-Thrush,
male and female.

"Sydney" Painting No. 5
Olive-backed Oriole.

"Sydney" Painting No. 32
Indeterminable.

"Sydney" Painting No. 33.
Red-backed Wren, male.

Reproduced by courtesy of the Mitchell Library, Sydney.

Photo: K. A. Hindwood

"Sydney" Painting No. 71.
Top figure: White-naped Honeyeater.
Bottom left: Yellow Robin.
Bottom right: Eastern Spinebill.

"Sydney" Painting No. 84.
Norfolk Island Pigeon
(Extinct).

"Sydney" Painting No. 90.
Little Bittern.

"Sydney" Painting No. 98.
Pied Goose.

Reproduced by courtesy of the Mitchell Library, Sydney.

Photo: K. A. Hindwood

François Laporte, Comte de Castelnau.

From *Illustration,* 1847.

The late Theo Athol Everitt with some ornithological friends.

Left to right: G. P. Whitley, T. A. Everitt, A. J. Moran, T. Iredale and A. H. Chisholm.

An informal street photograph, Sydney, 1950.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

MEMBERSHIP.

(The Society's year commences on 1st July)

Fees commencing 1st July, 1965 as follows:

Class	*Amount of Subscription*
Associate Member	£1 1 0 per annum
Ordinary Member	£2 2 0 „ „
(Members joining after 1st January in any year pay one-half subscription.)	
Life Associate Member	£10 0 0 in one sum
Life Member	£21 0 0 „ „ „
Honorary Member	Elected for services to Australian Zoology or to the Society.
Honorary Associate Member	Elected for services to Australian Zoology or to the Society.
Junior Members (aged 16 or under)	5 0 per annum

In 1966 the above amounts will be convertible into dollars and cents.

TITLES.

(Conferred by the Council)

Fellow		For valuable services to the Society or to Australian Zoology
Associate Benefactor	For contribution of £100	to the Society's Funds
Benefactor	„ „ £500	„ „ „ „
Endowment Member	„ „ £1,000	„ „ „ „

PRIVILEGES

Members of all classes may attend all meetings of the Society and its various Sections. Every member (other than an Associate or Life Associate Member) receives a free pass to Taronga Zoological Park and Aquarium, and twelve tickets each year, admitting 12 adults or 24 children to the Park only.

APPLICATION FOR MEMBERSHIP

should be addressed to the Honorary Secretary, Royal Zoological Society of New South Wales, 28 Martin Place, Sydney.

PUBLICATIONS

"The Australian Zoologist," published at irregular intervals since 1914 .
"Proceedings," published annually since 1933-34.

AUSTRALIAN ZOOLOGICAL HANDBOOKS AND SPECIAL REPRINTS.

"Bibliography of Australian Entomology, 1775-1930," by A. Musgrave, 1932.
"Australian Insects," by K. C. McKeown, 1947.
"A Check List of the Birds of Paradise and Bower Birds," by T. Iredale, 1948.
"Revision of the New South Wales Turridae," by C. F. Laseron, 1954.
"The Published Writings of Tom Iredale, with an Index of his new Scientific Names," by D. F. McMichael & G. P. Whitley, 1956.
"A Reclassification of the Order Odonata," by F. C. Fraser, 1957.
"Dragonflies of Australia," by F. C. Fraser, 1960.

Orders and enquiries should be sent to the Honorary Secretary, Royal Zoological Society of New South Wales, 28 Martin Place, Sydney.
Telephone No.: 55-1397

CONTENTS OF THIS PART

Wholly set up and printed in Australia for the Royal Zoological Society of New South Wales by

Surrey Beatty & Sons, Rickard Road, Chipping Norton, N.S.W. — 602-7404,

6149

X

THE
AUSTRALIAN ZOOLOGIST

Issued by the

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

VOLUME XIII — PART 3

JULY 6, 1966

Price: One Dollar 50 ($1.50)

All communications to be addressed to the Hon. Secretary,
Royal Zoological Society of New South Wales,
c/o The Australian Museum,
P.O. Box A.285, Sydney South, N.S.W.

Registered at the G.P.O., Sydney, for transmission by post as a periodical.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

Established 1879.

Registered under the Companies Act, 1899 (1917).

Patron:

His Excellency the Governor of New South Wales,
Sir Arthur Roden Cutler, V.C., K.C.M.G., C.B.E., Kt. St. J.

Vice-Patrons:

Sir Edward Hallstrom, K.B., F.R.Z.S.
Aubrey Halloran, O.B.E., B.A., Ll.B., Ll.D., F.R.Z.S.

COUNCIL, 1965-66

President:

John Cameron Yaldwyn, M.Sc., Ph.D.

Vice-Presidents:

Henry John de Suffren Disney, M.A.
Lawrence Courtney-Haines, A.Mus.A., L.T.C.L.
Frank Hamilton Talbot, M.Sc., Ph.D.
Gilbert Percy Whitley, F.R.Z.S., R.A.O.U.

Hon. Secretary: Mrs. Leone Harford.

Honorary Editor: Gilbert Percy Whitley, F.R.Z.S., R.A.O.U.

Honorary Treasurer: John Miles Campbell, J.P.

Members of Council:

John Miles Campbell, J.P.
Henry John de Suffren Disney
John Leonard Fry
Ernest Jeffrey Gadsden
Maxwell Hall Gregg
Lawrence Courtney-Haines
John Hallstrom
Mrs. Leone Harford
Frank McCamley
Basil Joseph Guy Marlow, B.Sc. (Hons. Lond.), F.Z.S.
Anthony Irwin Ormsby, Ll.B.
Peter Edward Roberts
Courtenay Neville Smithers
Frank Hamilton Talbot, M.Sc., Ph.D.
Ellis le Geyt Troughton, F.R.Z.S., C.M.Z.S.
Gilbert Percy Whitley
Mrs. Olive Wills
John Cameron Yaldwyn

OFFICERS:

Honorary Solicitor: Aubrey Halloran, O.B.E., B.A., Ll.B., Ll.D., F.R.Z.S.

Honorary Auditors: Messrs. Peat, Marwich, Mitchell and Company.

Honorary Librarian: Mrs. Leone Harford.

Assistant Honorary Secretary: Mrs. Olive Wills.

Assistant Honorary Treasurer: (Vacant)

OFFICERS OF SECTIONS:

Entomological Section:
Chairman: Mr. M. Gregg
Hon. Secretary: Mrs. V. Gregg

Conchological Section:
Chairman: Mr. F. McCamley
Hon. Secretary: Mrs. O. Wills

Junior Group:
Chairman: Mrs. L. Harford

Ornithological Section:
Chairman: Mrs. L. C. Haines
Hon. Secretary: Mr. H. Battam

THE AUSTRALIAN ZOOLOGIST

VOLUME XIII PART 3

THE SOCIETY'S PATRON

His Excellency the Governor of New South Wales, Sir Arthur Roden Cutler, V.C., K.C.M.G., C.B.E., Kt. St. J., has honoured the Royal Zoological Society of New South Wales by becoming its Patron.

A NEW HYLID FROG FROM AUSTRALIA

by HAROLD G. COGGER

(Plate XII & Text-figure 1.)

In the early part of 1965 the author received a fine series of living frogs from Mrs. N. Morris of Cairns, Queensland. All specimens were collected in the Cairns district or immediate hinterland. Included in this collection were several specimens of an undescribed frog possessing an arciferal pectoral girdle, broadly expanded sacral diapophyses and intercalary cartilages—a combination of characters found only in the family Hylidae. It is a member of the genus *Hyla* as defined by Goin (1961) and is the smallest species of this genus so far recorded from Australia. Upon comparing these specimens with all of the species of hylid frogs currently recognised from Australia and New Guinea there seemed little doubt that they represented an undescribed species. The only species showing any potential affinity with these Cairns specimens was *Hyla dorsalis* (Macleay), a diminutive species described in 1878 from Papua. However, the type of *Hyla dorsalis* was lost more than 50 years ago and the original description is brief and undiagnostic. Up to the present time the recognition of *Hyla dorsalis* has rested on a single specimen collected in 1955 and identified as this species by Loveridge (1956). Although the specimens from Cairns differed significantly from Macleay's description of *Litoria dorsalis* and from Loveridge's description of his specimen, the latter has been examined and found to be closely allied to the Cairns material.

In the following section the status of *Hyla dorsalis* (Macleay) is briefly discussed. As a result of this discussion the species is redescribed and recorded from Australia for the first time. A new Australian subspecies is described. In the following descriptions the standard measurements for tibia length (TL), eye-naris distance (E-N), internarial distance (IN) and diameter of tympanum follow the methods established by Zweifel (1962).

THE STATUS OF *HYLA DORSALIS* (MACLEAY)

Macleay (1878) described *Litoria dorsalis* from a single specimen from Katow, on the southern coast of New Guinea. Katow was located on what is now known as the Binaturi River, a small river on the mainland almost opposite the island of Daru on the south-western coast of the Territory of Papua. Macleay's brief description reads as follows: "Elongate. Snout pointed. Mouth opening beneath. Nostrils in a lateral depression, close to the snout. Fingers and toes with a well-defined roundish disk, the toes webbed only at the base. Tongue not notched behind. Vomerine teeth in two very oblique short series, with the internal nostril on each side large and oval. Skin of back smooth, of belly granular. Colour, above, dark with a broad central whitish band from the snout to the anus, beneath yellowish, much clouded with brown on the throat and chest. Length of body, 9; width, 2½; length of legs, 16 lines. One specimen from Katow, probably immature."

Fry (1913), in a review of Macleay's New Guinea frog types, stated that he was unable to locate the type of *Litoria dorsalis* and he presumed that the specimen was lost. A further search in the Macleay Museum and the Australian Museum by the author has confirmed, beyond reasonable doubt, the loss of the type. Fry then went on to state that ". . . Macleay's description is unintelligible. From the fact that the toes are webbed only at the base it is obviously not a Hyla. The "mouth opening beneath" and the presence of discs to the fingers suggests that it belongs to some disked Engystomatid genus,

while the latter character, coupled with a basal web to the toes, points to Cornufer affinities. I can find no description which could reasonably be said to tally with Macleay's generalised characters. Taking these facts into account, the most satisfactory procedure will be to totally ignore the name *Litoria dorsalis,* Macleay, and to exclude it from future literature."

Although one sympathises with Fry in his frustrating attempts to clarify the status of Macleay's frog types, his total rejection of *Litoria dorsalis,* simply on the basis of its failure to correspond to any other known hylid species, was unwarranted. Subsequently van Kampen (1923) doubtfully included *Hyla dorsalis* in his list of Indo-Australian hylid frogs.

The status of the species thus remained unchanged until Loveridge (1956) obtained a single specimen of a small hylid frog from the Aramia River, Papua. This specimen, which was collected by K. R. Slater in 1955, proved to be a gravid female although only 20 mm. in length. On the basis of its small size at maturity and its close correspondence with Macleay's description of *Litoria dorsalis* Loveridge considered that his specimen represented the rediscovery of Macleay's species.

The specimens from Cairns, Queensland, with which this paper is largely concerned, represent a new addition to the frog fauna of Australia. In morphology they closely resemble Loveridge's Aramia River specimen and another specimen of a small hylid frog collected by the author at Lake Murray, Papua, in 1963. Although differences between the Papuan and Australian specimens are of such an order as to possibly justify the erection of a new species to accommodate the Australian material, as specimens from the two areas show a close affinity which is not shared with any other species from either region, the author believes that such affinity (and its zoogeographic implications) would be obscured by making the Australian specimens a distinct species. Until such time as additional material from both Papua and Australia will permit a more accurate analysis of relationships, the author believes that the most satisfactory means of indicating presumed affinities is to establish a subspecific relationship between the Australian and Papuan populations. However this decision raises a taxonomic problem and necessitates a reassessment of the status of the Papuan species represented by Loveridge's Aramia River specimen.

In the interest of nomenclatural stability it was initially proposed to designate this specimen as neotype of *Litoria dorsalis* Macleay. While aware of the requirements and recommendations, including the "exceptional circumstances" clause, of Article 75 of the 1961 International Code of Zoological Nomenclature, it was felt that the present situation would justify such an action. However in accordance with Recommendation 75A the author contacted Mr. M. J. Tyler of the South Australian Museum for his views on such a procedure. Mr. Tyler, who is currently revising the hylid frogs of New Guinea, disagreed with this neotype proposal and expressed the view that inconsistencies between Loveridge's specimen and Macleay's description of *Litoria dorsalis* preclude the possibility that the two are conspecific.

In the light of these views it would be wrong to formally associate the name *dorsalis* with Loveridge's specimen by making the latter a neotype. Nevertheless as the author considers that there is no valid reason for rejecting Loveridge's action, a brief redescription of *Hyla dorsalis* (Macleay) based on the specimens from the Aramia River and Lake Murray is given in the following section. The reasons for supporting Loveridge's action are as follows:— An examination of Loveridge's Aramia River specimen reveals no features inconsistent with Macleay's description of *Litoria dorsalis.* In all specimens examined there is a broad, light coloured vertebral band which, contrary to the contention of Loveridge (*loc. cit.*) is not inconsistent with Macleay's description of "a broad, central whitish band" in the Katow holotype. Although Loveridge does not mention the condition of the vomerine teeth, his specimen has two small, but prominent, round vomerine elevations between the relatively large choanae.

Macleay stated that the type of *Litoria dorsalis,* which was 9 lines (19 mm.) long, was "probably immature," whereas Loveridge's 20 mm. specimen is a gravid female. In view of the fact that the present material represents the smallest hylid frog known from the Australian region, any opinion not based on dissection (which would have established whether the type was or was not sexually mature) would surely have tended to be that such a small animal was "probably immature."

Only in the extent of the webbing between the toes does there appear to be any lack of agreement between the specimens available and Macleay's description, but even in this the difference is more apparent than real. In all specimens the webbing between the toes scarcely reaches beyond the distal subarticular tubercle of any digit. The difficulties inherent in attempting to define, quantitatively, the extent of webbing between the toes of frogs are stressed by Peters (1964). The term "basal webbing" is ill-defined even today, yet one must consider it within the context of the uncritical work and brief descriptions of Macleay. In the living specimen illustrated in Plate xii, fig. a, the webbing does not extend distally as far as the visible parts of the hind foot. In life, and in some of the preserved specimens here discussed, the webbing could reasonably be defined as basal.

As the type of *Litoria dorsalis* has been lost then the literal accuracy of Macleay's description must be accepted; one should not be concerned with his omissions. But as the type is lost and the original description is brief and not diagnostic, there must always remain some uncertainty as to the true identity of *dorsalis.* Nevertheless if the original description, though incomplete, fits a known but otherwise undescribed taxon then it is felt that the best interests of taxonomy are served by associating the two. To erect yet another name for the material on hand is not only unnecessary in these circumstances but would simply perpetuate a *nomen dubium* in future literature. Therefore on the weight of evidence available to the author there appears to be no sound reason for rejecting at this time the conspecificity of *Litoria dorsalis* and Loveridge's Aramia River specimen. Whether this view will be upheld in subsequent discussions and investigations by other workers remains to be seen. However it is believed that future settlement of the status of *Litoria dorsalis* can only be assisted, and in no way complicated or hindered, by the actions taken in this paper.

REDESCRIPTION OF *HYLA DORSALIS* MACLEAY

The following description is based on specimen No. 28389, a female, in the collection of the Museum of Comparative Zoology at Harvard University, from the Aramia River, Papua and on specimen No. R24248, a female, in the Australian Museum, Sydney, from Lake Murray, Papua. Dimensions of these specimens are given in Table 1.

Diagnosis: *Hyla dorsalis* may be distinguished from all other members of its genus in the Australasian region by the following combination of characters: small size at maturity (17 mm. for males, 20 mm. for females); fingers free of webbing; toes half webbed or less; one to several low, rounded tubercles over each eye. An additional regional diagnosis for Australian specimens is provided in a following section.

Description: Habitus slender. Snout rather acutely pointed, projecting well in front of lower jaw. Pupil horizontal. Tympanum, though distinct, is pigmented, suggesting that shrinkage in preservative might account for the prominence of the rim of the tympanic aperture. A slight supra-tympanic fold.

Skin smooth on the back of the adult Aramia River female, but the juvenile from Lake Murray has a series of very low, discontinuous dorso-lateral folds. Several low, rounded tubercles over each eye. Skin of throat smooth, that of belly coarsely granular. No pectoral fold. Limbs with smooth skin.

Finger discs well-developed, wider than long. Fingers without a trace of webbing. Fingers in order of length 3, 4, 2, 1. Subarticular tubercles moderately developed.

Hindlimb relatively long and slender. Toe discs well-developed, about same size as those on fingers. Heel of adpressed hind limb reaches to between the eye and tip of snout. Toes with well-developed webbing, the latter scarcely reaching beyond the distal subarticular tubercle of any digit. Toes with distinct fringes to discs. Subarticular tubercles moderately developed. A prominent inner metatarsal tubercle. Outer metatarsals united, the proximal of a series of small metatarsal tubercles under the fourth metatarsal constituting what might be considered as a small outer metatarsal tubercle.

Vomerine teeth present in the adult female from the Aramia River as two small but prominent round projections between the large, oval choanae; vomerine elevations are not visible in the juvenile from Lake Murray. Tongue oval, about one-third free behind.

Colour of adult female rich brown above except for a broad band of darker brown on each side extending from above each eye, dorso-laterally, to about half-way along the flanks. This results in the impression of a broad, lighter-coloured vertebral band. The chromatophores of the dorsal surface are not uniformly distributed, resulting in a slightly mottled appearance. A dark brown stripe commences above the tympanum and follows the supra-tympanic fold over the base of the forelimb. Anterior lateral surfaces dark brown, posterior lateral surfaces and groin whitish with a few scattered brown flecks. Upper jaw mottled with light and dark brown, an oblique dark bar or patch extending forward from beneath the eye to the mouth. An indistinct dark brown bar along the anterior edge of the basal part of the forelimb. A dark band along the hind edge of the forelimb below which, on the forearm, is a series of three or four white spots. Hind edge of thighs light brown flecked with white. Remaining dorsal surfaces of limbs mottled with light and dark brown. Ventral surfaces white, strongly peppered with brown on the throat, chest, anterior abdominal region and limbs. Rim of lower jaw rich brown.

The juvenile female is lighter in colour than the adult, being light grey above with irregular dark mottling. A slightly darker region between the eyes results in a light triangular patch bounded by the canthus on either side and a line between the anterior corners of the eyes. The dark, dorso-lateral patches of the adult are absent, but the dark bar from above the tympanum to the flank is conspicuous, as is the dark patch between the eye and the mouth. Each of the low, discontinuous dorso-lateral folds is bordered below by a dark brown patch. The upper surfaces of the limbs are light grey uniformly peppered with brown. The ventral surfaces are white, lightly but fairly uniformly peppered with brown.

A new subspecies from Australia is described below.

HYLA DORSALIS MICROBELOS, SUBSP. NOV.

(Plate XII and text-fig. 1)

Holotype: A male, R25836 in the Australian Museum, Sydney. From Cairns, Queensland, collected by Mrs. N. Morris in February, 1965.

Paratypes: Two males, R25837 and R25839 (the latter prepared as an alizarin skeletal transparency), and a female, R25838, in the Australian Museum. All with the same data as holotype.

Diagnosis: *Hyla dorsalis microbelos* may be distinguished from the nominate race by the absence of vomerine teeth in adult specimens and by its reduced ventral pigmentation. In *dorsalis dorsalis* the brown of the ventral surface is distributed more or less uniformly over the throat and chest. In *dorsalis microbelos* the ventral pigmentation is concentrated around the lower jaw, the centre of the chest and on the hind limbs.

Hyla dorsalis microbelos may be distinguished from *Hyla bicolor*, the only other Australian *Hyla* lacking vomerine teeth (Copland, 1957) by the following features: (a) an E-N/IN ratio exceeding 1.15 (an average of 0.92, range 0.81-1.07 in a series of twenty-seven *bicolor* from Australia and New Guinea), (b) the absence of a pectoral fold in life (at least one strong pectoral fold in *bicolor*), (c) the variegated brown dorsal colour (typically green in *bicolor*, though occasionally uniform brown), (d) the tubercles on the dorsum (smooth dorsum in *bicolor*) and (e) the webbing between the toes (fig. 1) never reaching beyond the distal subarticular tubercle of any digit (the webbing in *bicolor* reaches the level of the intercalary cartilage of the first, second, third and fifth toes).

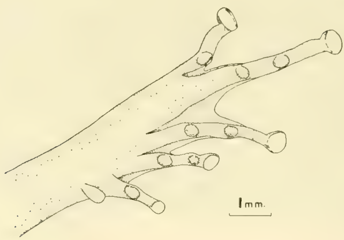


Fig. 1: Lower surface of foot of holotype of *Hyla dorsalis microbelos*.

Of the Australian species of *Hyla* with vomerine teeth, *H. dorsalis microbelos* (in which vomerine teeth are lacking) most closely resembles the so-called "ground hylas" of Moore (1961), all of which are at least two and a half times as long as *dorsalis microbelos* when mature and all of which possess a small outer metatarsal tubercle. The latter is absent in *dorsalis microbelos*.

Description of Holotype: Habitus very slender. Snout-vent length 17.2 mm. Snout rather acutely pointed, projecting well in front of lower jaw. Diameter of eye (maximum, horizontal) 2.00 mm. Pupil horizontal. Distance from anterior corner of eye to centre of naris (E-N) 1.85 mm. Internarial distance (IN) 1.54 mm. Tympanum covered with skin but rim of tympanic aperture clearly distinguishable, its diameter 1.00 mm. No supratympanic fold. Distance from posterior edge of tympanum to tip of snout 4.81 mm.

A discontinuous dorso-lateral fold made up of a series of low tubercles or short folds; a few low, rounded tubercles along the sides (below the dorso-lateral folds) and above each eye. Skin of remaining dorsal surfaces smooth. Skin of throat smooth, that of belly coarsely granular. No pectoral fold. Limbs with smooth skin.

Finger discs well-developed, wider than long; width of disc of third finger 0.58 mm. (58% of diameter of tympanum). Fingers with hardly a trace of webbing. Fingers in order of length 3, 4, 2, 1. Subarticular tubercles moderately developed.

Hindlimb relatively long and slender; tibia length 8.66 mm. Toe discs well-developed, slightly larger than those on fingers; width of disc of fourth toe 0.65 mm. (65% of diameter of tympanum). Heel of adpressed hind limb reaches to about the centre of the eye. Toes with well developed webbing, roughly 50%; webbing does not reach beyond the distal subarticular tubercle of any digit. Toes with hardly discernible fringes to discs. Subarticular tubercles moderately developed. A prominent inner metatarsal tubercle; no outer tubercle.

Vomerine elevations absent. Tongue sub-circular, about one-third free behind. A prominent external vocal sac; its openings in the floor of the mouth are longitudinal slits, one on each side lying below the lateral edge of the tongue.

Cream-coloured above with numerous dark brown chromatophores which sometimes coalesce to give a peppered appearance. Larger groups of chromatophores give a mottled appearance on the snout, head and nape. A definite, though poorly-defined, dark brown stripe runs from the nostril along the canthus to the eye. A broader dark brown band from the eye, through the tympanum (although the tympanum itself is lighter) and over the base of the forelimb to about half-way along the flank. A distinctive short, dark brown bar along the anterior edge of the basal part of the forelimb, just extending on to the elbow, and discontinuous with a similar bar on the hind edge of the distal part of the forelimb. An indefinite darker brown band along the anterior edge of the hindlimb. Upper (exposed) surfaces of limbs strongly peppered with brown, the latter sometimes coalescing to form faint mottling, especially on the fore and hind sides of the thighs. Ventral surface and concealed (resting) surfaces of limbs immaculate white, except for very fine peppering on the infralabial region, the lower surfaces of the hindlimbs and the chest, and heavy brown spotting on the lower surfaces of the hands and feet.

Variation: The paratypes differ from the holotype only in size. The female which, of course, lacks a gular sac, is significantly larger. The dimensions in mm. of the paratypes are given in Table 1 below.

The female paratype died in captivity and was preserved some hours after death. Although some decomposition had occurred, the ovaries were enlarged and mature, containing large numbers of small, darkly pigmented eggs. The testes of the male paratype are small, but those of the holotype are large (2.0 mm. in length) and apparently mature. Hence it is assumed that the snout-vent lengths of the four specimens obtained approximate average adult size.

Distribution: Known only from the type locality, Cairns, Queensland.

Habitat: Mrs. Morris states that with the exception of the female which entered a house during rain, all specimens were collected " . . . in a thicket of reeds about four feet high . . . in a gutter opposite the playing fields in Cairns." They were found only during rainy weather and were located by their calls. The males, according to Mrs. Morris, ". . . have a large transparent vocal sac and make an incredible amount of noise for such a small animal." The call of the male in breeding chorus ". . . is like that made by those grasshoppers which have leaf-shaped wings (presumably members of the orthopteran family Tettigoniidae—H.G.C.) and is every bit as penetrating."

The subspecific name alludes to the acute, javelin-like appearance of this diminutive frog.

Acknowledgements: The author is especially grateful to Mrs. Noreen Morris, not only for the material described in this paper and its associated field notes, but also for her enthusiastic collecting on behalf of the Australian Museum. He is also indebted to Mr. M. J. Tyler for his views on the taxonomic problems outlined in this paper and to Dr. Ernest Williams for the loan of Loveridge's Aramia River specimen. Mr. H. Hughes prepared two of the photographs used in plate xii.

Table 1: Dimensions in mm. of *Hyla dorsalis dorsalis* and paratypes of *Hyla dorsalis microbelos*

	28389	R24248	R25838	R25837	R25839
Snout-vent length	19.8	12.7	20.15	17.9	17.3
Tibia length	10.6	6.8	10.08	9.3	8.9
Internarial distance	1.69	1.17	1.63	1.65	1.53
Eye-naris distance	2.09	1.50	2.15	2.00	1.95
Diameter of eye	2.24	1.75	2.22	2.00	2.10
Snout to posterior edge of tympanum	6.38	4.63	7.05	5.16	5.22
Diameter of tympanum	1.05	0.84	1.13	1.04	1.10
Width of disc of third finger	0.84	0.50	0.58	0.50	0.64
Width of disc of fourth toe	0.83	0.55	0.63	0.50	0.68

Literature Cited

Copland, S. J., 1957.—Australian Tree Frogs of the Genus *Hyla*. *Proc. Linn. Soc. N.S.W.*, 82(1):9-108.

Fry, D. B., 1913.—A re-examination of Macleay's New Guinea and Queensland frog types. *Mem. Qd. Mus.*, 2:49-50.

Goin, C. J., 1961.—Synopsis of the genera of hylid frogs. *Ann. Carneg. Mus.*, 36(2):5-18.

Kampen, P. N. van, 1923.—The Amphibia of the Indo-Australian Archipelago. E. J. Brill, Leiden. p. 65.

Loveridge, A., 1956.—Rediscovery of *Hyla dorsalis* and *Lechriodus papuanus* in New Guinea. *Breviora*, 55:1.

Macleay, W., 1878.—The *Batrachians* of the Chevert Expedition. *Proc. Linn. Soc. N.S.W.*, 2(2):138.

Moore, J. A., 1961.—The Frogs of Eastern New South Wales. *Bull. Amer. Mus. Nat. Hist.*, 121(3):151-385.

Peters, J. A., 1964.—Dictionary of Herpetology. Hafner, New York. p. 386.

Zweifel, R. G., 1962.—Results of the Archbold Expeditions. No. 83 Frogs of the Microhylid Genus *Cophixalus* from the Mountains of New Guinea. *Amer. Mus. Nov.*, 2087:1-26.

Explanation of Plate XII

Hyla dorsalis microbelos subsp. nov.

A. Photograph of living male. Photo: Author.

B. Dorsal view of holotype.

C. Ventral view of holotype.

Photo: H. Hughes

BUDGERIGAR SURVEY

In connection with a research project investigating adaption of birds to the desert environment, I am making a survey of nomadic behaviour of the Budgerigar.

I would like to ask the help of any member who has personal records or knows of literature records of either (a) breeding congresses of these birds, i.e., more or less high density breeding associations surrounded mainly by areas of little or no breeding, or (b) large non-breeding flocks as occasionally seen at waterholes, in flight, etc.

I am aware of the time and effort required to search through personal records, but please do not hesitate to write, no matter how insignificant your information may seem. Each item *is* important in itself, as the sum total of many records may give clearer understanding of the pattern of movement as a whole in this species.

Eric Lindgren, Dept. of Zoology, University of W.A., Nedlands, W.A.

SOME EARLY REFERENCES TO THE EXTINCT MARSUPIAL, ZYGOMATURUS

By G. P. Whitley

(Plates XVIII-XIX)

The palaeontologist is thrilled by the fossils he finds embedded between the ancient strata of the earth; the bibliographer finds his enjoyments pressed between pages of old books and papers. Sometimes the two have something of satisfaction to show one another.

In the course of some research into the history of the Australian Museum, Sydney, I came across several references to a new genus of fossil marsupial called *Zygomaturus* which were considerably earlier than the dates of publication indicated by Neave's *Nomenclator Zoologicus* and by standard authors. It was not clear where or when the genus had first been named, though T. S. Palmer's *Index Generum Mammalium* (1904, pp. 717 & 880) was nearest the mark. I found that *Zygomaturus* (a *genus caelebs,* without a named species) was introduced in an anonymous article in the *Sydney Morning Herald* newspaper of the 9th September, 1857. It was later revealed by Owen that the author of this article was William Sharp Macleay. Owen thought *Zygomaturus* was a synonym of *Nototherium* (one of several points upon which Krefft clashed with him), but it is regarded as distinct by modern palaeontologists. In Australia in the 1850's there were few or no local scientific publications, so discoveries were often announced in the daily or weekly press before being posted to England or Europe to take their chances of publication there.

Old files of newspapers have been consulted by me in the Public Library of New South Wales, Sydney, to the Trustees of which I express my thanks for facilities. I also thank Professor R. A. Stirton of the University of California, Mr. H. O. Fletcher of the Australian Museum, Sydney, Mr. John Calaby of C.S.I.R.O., Canberra, and Mr. E. O. G. Scott of Launceston, who have kindly given me helpful advice in the matter of *Zygomaturus.*

Here, then, is a copy of the first printed account of:

ZYGOMATURUS

(Anonymous), *Sydney Morning Herald* (newspaper),
September 9, 1857, page 2.

"Donations to the Australian Museum during August, 1857" (Includes):

"FOSSIL SKULL of a new marsupial animal, which bears a nearer approach to Diprotodon than to any other known genus. The size was apparently that of a large ox; and the skull agrees with that of the Megatherium, and others of the American tardigrade edentata (living and extinct) in having a long apophysis descending from the zygomatic arch, as well as in other particulars. However, this process of the zygoma exists in the Diprotodon, and may be detected even in the kangaroo. Another characteristic of this new quadruped, which may be called *Zygomaturus,* is the great distance of the zygomatic arch from the temporal bone. The breadth of the skull at the widest part, namely, about the centre of the zygoma is fifteen inches; the extreme length of the skull is about eighteen inches. In the Diprotodon the skull is on the other hand about three feet long by one foot eight inches broad; so that while the Diprotodon must have had a facies somewhat like that of a kangaroo, the facies of the *Zygomaturus* must have been about as broad and short in proportion as that of a wombat. The lower jaw of the specimen in the Museum is wanting, but the formula of dentition in the upper jaw is as follows:— 6 incisors, 0 canines, 10 molars. The two front incisors are very long and strong, as in the kangaroo and Diprotodon. The above dental formula agrees with that of Diprotodon, except that the latter animal had only eight molars in the upper jaw. The *Zygomaturus* had many points of structure approaching those of the rhinoceros and tapir family. For instance, the molars resembled in form those of the tapirs, while the nasal septum may remind us of the *Rhinoceros tichorhinus,* a fossil species that formerly inhabited England and other parts of Europe. The strong and very prominent trefoil-shaped arch formed by the extremity of the nasal bones, shews that if the *Zygomaturus*

did not possess a snout, like that of a tapir, it must, at least, like a rhinoceros, have had a horn (perhaps a double one) on the nose. Without doubt this horn was used for grubbing up the roots of aquatic plants, since, like the pachyderms, to which it bears so close an affinity, in all probability the *Zygomaturus* passed its life in marshy places. The extraordinary width of the temporal fossoe denotes that the animal possessed enormous powers of biting and mastication. This skull belonged to an adult animal, as the molars are considerably ground down. Also the upper jaw of a young *Zygomaturus*, as appears by the tips of the molars being perfect. Another portion of an upper jaw, and a humerus, probably of a *Zygomaturus;* base of left ramus of the lower jaw of Diprotodon; and front incisors of ditto. All the above fossil remains are from King's Creek, Darling Downs, being the same locality whence the entire skull of the Diprotodon was obtained some years ago. [Donated by] Frederick Isaacs, Esq., Gowrie, Darling Downs." [Queensland].

Other early references to *Zygomaturus*, with notes, are as follows:

(1) Sir William Denison wrote a letter, dated Sydney, 6th November, 1857, in which he mentions that Dr. Macdonald of H.M.S. "Herald" has described *Zygomaturus* better than he (Denison) had done in his last letter to Sir Roderick Murchison (Denison, Varieties of Vice-Regal Life I, 1870, p. 427).

(2) Richard Owen, Proc. Geol. Soc. Lond. XIV, March 10, 1858, pp. 541-543. Abstract of a memoir. Here the specific name *Z. trilobus*, from W. S. Macleay's MS., appears to be published for the first time.

(3) An anonymous article, "The Ancient Giants of Australia," in *Sydney Morning Herald* newspaper, April 15, 1858, p. 4 and a letter written on 30th December, 1858 about "The native 'lion' of Australia" by W. S. Macleay in the *Sydney Morning Herald* of 1st January, 1859, p. 5.

(4) Dr. John Shaw (A Gallop to the Antipodes . . . 1858, p. 233) describes his visit to the Australian Museum and says, "Among the newly discovered fossils were the *Zygomaturus trilobus*, and the *Diprotodon* from Darling Downs." He gave no further details and the specific name *trilobus* he may have copied from a museum label.

(5) When the Austrian frigate "Novara" visited Sydney in 1858, its scientists were provided with "casts of the fossil skull and bones of the Diprotodon and other extinct Australian mammals." (Australian Museum Annual Rept., 1858, p. 1). Perhaps a cast of *Zygomaturus* was included?

(6) Owen, *Quart. Journ. Geol. Soc.*, XV, Feb. 1859, pp. 168 & 174. Owen remarks that *Zygomaturus* was the name given by Macleay and so was *Z. trilobus*, but this species-name, as we have seen, did not appear in the original newspaper account. Owen considered *Z. trilobus* to be a synonym of *Nototherium mitchellii* (see Owen, 1877, *Researchs on the fossil remains of the extinct mammals of Australia* (London: Erxleben), 2 vols., especially i, p. 250 et seq.). Owen had written to Macleay ". . . and I received a friendly and favourable reply in a letter dated 9th March, 1858, in which Mr. W. S. Macleay writes:— 'Every month a list of donations received is published in our local newspapers, and it is true that in one of such monthly lists I lately wrote of this "*Zygomaturus*" a few words which you appear to have seen. They are, however, principally intended to please the donor, and to induce him to send us more specimens. The name, from the "tail" or process of the zygoma, was given on the principle we adopted of cataloguing every thing, were it only for the purposes of correspondence and exchange. You ask for a cast of the skull of the *Zygomaturus*, and I am glad to think that, long ere you receive this letter, you will have had in your hands a cast that Mr. Want, a Trustee for our Museum, took home for the British Museum . . .' ".

(7) Krefft, 1870, *Guide to the Australian fossil remains*.

(8) Parliamentary report of 1870, correspondence relating to the Wellington Caves, contains letters and lists by Krefft and *Z. macleayi*. sp. nov., p. 5, pl. iv, fig. 4.

(9) Krefft, 1871, Austr. Vertebrata, p. 19.

(10) Sydney Mail, 13th May, 1871, p. 313. Unfortunately, files of Sydney newspapers for 1870 and 1871 are lacking in some parts so that some historic notes on fossils and on the discovery of the Queensland Lungfish, etc. may have vanished.

(11) Holograph letter from Owen to Krefft dated 5th April, 1872 (Original in Mitchell Library, Sydney, Krefft MSS., Vol. A. 261). Krefft's articles in *Sydney Mail,* April 20, 1872, p. 488 (*Z. creedii,* nom. nud.) and June 8, 1872, p. 713, figs. (restoration and skull of *Z. trilobus*), reproduced here, plate XIX.

(12) R. Etheridge, 1878, A Catalogue of Australian Fossils, p. 195. *Zygomaturus* is ascribed to "Macleay, 1857? (Cat. Donations . . .)" Later, and independently of myself, Etheridge had discovered the type-description, for, in his interleaved copy of the Catalogue, in the Australian Museum, Etheridge had added in ink: "The reference 'Cat. Donations' &c. should read Donations to the Australian Museum during August, 1857, and was only the usual monthly statement of gifts at that time always published in the 'Press.' The list was by W. S. Macleay and is the first announcement of his genus *Zygomaturus* (*Syd. M. Herald* xxxviii, no. 6009, 1857 [9th Sept.] p. 2)."

(13) G. Krefft, "Mammals of Australia and their Classification. Part I. Ornithodelphia and Didelphia." Sydney Mail, 8th Nov. 1873, pp. 594-595 and plates i-ii as a supplement. Plate I shows *Diprotodon Bennettii* (Krefft) and *D. australis* (Owen); Plate II shows *Zygomaturus Creedii* (Krefft) and *Nototherium Mitchelli* (Owen).

New genera and species of fossils were named by Krefft in the Sydney newspapers. They would have been formally published in a fine, illustrated scientific report, but Krefft was having serious troubles during the 1870's, and so palaeontology still suffers. But that is another story.

De Vis (1907, Ann. Qld. Mus. 7:4) took exception to *Zygomaturus* because it was not announced in a publication addressed to the scientific world. He therefore renamed it *Simoprosopus* . . . "and for an emphatically flat-faced, snub-nosed creature, the one [name] above written seems appropriate."

To recapitulate, it appears that the names of the genus and oldest species should be ascribed as follows:

Genus *Zygomaturus* Anon. [= W. S. Macleay], 1857, *Sydney Morning Herald,* 9th Sept. 1857, p. 2.

Species: *Z. trilobus* Owen ex Macleay MS., 1858, Proc. Geol. Soc. Lond. xiv, March 10, 1858, p. 541.

Z. macleayi Krefft, 1870, Wellington Caves correspondence (Govt. Printer, Sydney), p. 5, pl. iv, fig. 4.

Z. creedii Krefft, 1873, Sydney Mail, Nov. 8, 1873, p. 595, pl. ii, figs. 7, 7a, 7b and 7c. Earlier referred to in the vernacular by Krefft, Sydney Mail, May 13, 1871, p. 345, but not latinized until pl. ii was published in 1873.

Explanation of Plate XIII.

Cartoon of Gerard Krefft as a conjuror, restoring the skull of a fossil marsupial, *Diprotodon,* for a simulacrum of Richard Owen. From Sydney *Punch,* 26 June 1874, from the original in the Mitchell Library, Sydney.

Inserted here as a palaeontological curiosity and because of the excellent likeness of Krefft, an early student of Australian fossils and discoverer of the Queensland Lungfish. The caption of the joke has long lost its point, but read as follows:

DIPROTODON ! !

"PROFESSOR KREFFT — THE GREAT WIZARD OF THE NORTH:— 'Now, this is the most remarkable trick, ladies and gentlemen, ever performed in the Australian Colonies. In this present enlightened age I don't intend to try to make you believe there is any witchcraft in it. The thing is perfectly easy when you once know how to do it. You see me CRUSH TO POWDER the jawbones of the great Australian Diprotodon, which I placed in this box; hey, presto! ! and here, Ladies and Gentlemen, you see them on the table, perfect as Professor Owen acknowledges that he received them! (LOUD APPLAUSE)."

The Wizard of the North was Professor Anderson, a conjuror who amazed Sydney audiences with his "clever acts of diablerie" in 1859.

Explanation of Plate XIX

Skull and restoration of *Zygomaturus trilobus.*

After Krefft, 1872.

GENERA PISCIUM: Work in Progress

By Gilbert P. Whitley

David Starr Jordan, in his *Genera of Fishes* and *Classification of Fishes*, tried to place each genus and subgenus of fishes, living and fossil, named between the years 1758 and 1923, in its proper family, without necessarily distinguishing between valid names, preoccupied names and synonyms. His tremendous work was published by Leland Stanford University, Palo Alto, California, between 1917 and 1923 and was out of print for some time before being reprinted in 1963 with a new foreword by George S. Myers and a comprehensive index. In the course of its preparation, Jordan had specially mentioned my late mentor in ichthyology, Allan R. McCulloch of the Australian Museum, Sydney, to whom Jordan wrote (*in lit.*, 16 May, 1922), "I have been more indebted to you than to anyone else of the men whose help I have called for," a striking tribute to Australia, for one would have expected that most assistance would have been forthcoming from older countries with their greater library resources. Yet McCulloch had managed to compile his data, by great personal diligence, far removed from all the classic centres of learning and at a time when one had to wait at least six months for a reply to a letter to the other side of the world. Since 1925, when McCulloch died, the increase in new names for genera and species of fishes has been phenomenal and the task of keeping up-to-date his manuscript lists and his card-index has grown accordingly.

Since there was no one else to do it, the present writer, McCulloch's successor as Curator of Fishes at the Australian Museum until 1964, decided to try to keep apace with the growing spate of genera (and incidentally with a selection of the even greater flow of new species, though these do not concern us here). This involved analysing the relevant literature, adding new or overlooked generic names to the families listed in McCulloch's now ageing exercise books, and writing so many card-index slips that the supplement to McCulloch's catalogue has exceeded its parent in size. Fools rush in where angels fear to tread, it is said, and one is only too conscious that what has been attempted in Sydney may or should have been done better in some other city. However, no sign of any similar undertaking appears to have emerged elsewhere. Indeed, it has been stated that no one in the United States at least has been found with both the ability and the time to carry through such an extensive revision. My own labours fall far short of the target aimed at and (to mix metaphors) have failed through trying to put new wine into old bottles. The whole task is really a continually changing process, which will have to be finished by other hands; the reader is asked to excuse the overuse of the personal pronoun in the sketch which follows of what this writer has attempted.

In March 1929, I commenced a handwritten alphabetical list of the names of fish genera by copying out all those in Jordan's indexes and amalgamating all additional ones. When I started this "Genera Piscium," as I called it, the whole of Sherborn's great *Index Animalium* had not been published, but Mr. C. D. Sherborn was mailing duplicate printers' proofs of it to his friend, Mr. Tom Iredale, then conchologist at the Australian Museum, who shared this treasure with me and also, over the years, helped me from his own taxonomic and bibliographical experience, for which I cannot adequately express my thanks. In July 1929, I sent to Professor D. S. Jordan a list of about 675 generic names omitted from, or published subsequently to, his *Genera of Fishes*. Others were furnished to Mr. S. A. Neave for his *Nomenclator Zoologicus* when I was in London in 1937. Some were variant or amended spellings, rather than entirely new generic names.

As a result of personally reading line by line through Sherborn's *Index Animalium* (in proof as well as in print), McCulloch's manuscripts, Agassiz's *Nomenclator Zoologicus,* certain old French Dictionaries of natural history, the *Index Zoologicus,* the Prussian Academy's *Nomenclator,* Weber & de Beaufort's *Fishes of the Indo-Australian Archipelago* and much general literature, including the essential portions of the *Zoological Record,* I had listed by March 1951 about three thousand names additional to those in Jordan's works. To these I have added all the new generic names for Recent and fossil fishes proposed in later years until now there are many more additions than there are generic names for fishes dating from 1758 to 1923.

Scudder's *Nomenclator* and Bleeker's *Atlas Ichthyologique* may still yield a few more names to closer scrutiny, but not many, I think.

In May 1950, I estimated that about ten thousand different names had been proposed for fish genera between 1758 and 1950. It had taken me eleven years to check my manuscript list with Neave's *Nomenclator Zoologicus* which, like Sherborn's *Index Animalium,* was amazingly complete. I sent a supplementary list of some 400 names to Neave in September, 1952—I had missed some which he had included, and vice versa.

The number of generic names proposed for fishes is estimated as follows: Treated in Jordan,

Genera of Fishes, Part 1, for 1758 to 1833 (part)	1247
Genera of Fishes, Part 2 for 1833 to 1858	1872
Genera of Fishes, Part 3 for 1859 to 1880	2065
Genera of Fishes, Part 4 for 1881 to 1920	2561
Classification of Fishes,	
Names overlooked, or published from 1920 to 1923	230
(Whitley, MS). Overlooked names, emendations, etc., 1758 to 1930	3137
New names proposed, 1931 to 1939	1100
New names proposed, 1940 to 1958*	1344
TOTAL, 1758 to 1958	13,556

All of the names published between 1758 and 1958 (and some of later date) have been checked to ascertain which ones were preoccupied. Many genera fell in this process, some to rise again under fresh names. One is impressed by a sad wastage: probably about 36% of the thousands of names are superfluous (being nomina nuda, nomina vana, homonyms or preoccupied names, variant spellings, primary or secondary synonyms) out of a possible number of about five thousand *valid* genera of fishes (fossil and Recent) in the world.

The initials E. and O.E. are always appropriate to a compilation of this kind: "errors and omissions excepted."

In a subsequent paper, or series of papers, I hope to furnish an alphabetical list of the genera of fishes additional to Jordan, 1963. Mere variant spellings, misprints or superfluous emendations will be excluded and references to literature will be found in Sherborn, Neave (whose sixth volume is eagerly awaited) or the *Zoological Record.*

In work of this kind, accuracy, patience and fairness to one's antecedents should prevail over arbitrary treatments which may bring temporary advantages only. Experience has suggested to this writer that quite rigid adherence to priority is preferable to a continuing changing or partial modification of the rules of nomenclature perhaps only to suit the conveniences of a few specialised students during a brief period of time.

* The final year 1958 was selected as being the bicentenary of Linne's *Systema Naturae,* ed. 10 (1758). In 1758, Linne had established only 61 genera. From 1940 to 1950, 720 new genera of fishes were named and from 1951 to 1958, 624. Since 1958 several hundred new names have been proposed so that compilation never ceases.

ACKNOWLEDGEMENTS

I acknowledge, with thanks, the helpful services of the library staffs of various institutions, but particularly of the Australian Museum, Sydney, the Public Library and Mitchell Library, Sydney, the Linnean Society of New South Wales, the Public Library and National Museum, Melbourne, and the National Library, Kingston, Canberra. A small but distinguished band of friends gave helpful advice and criticism from time to time: my thanks go to Carl Hubbs, Tom Iredale, the late David Starr Jordan, the late Anthony Musgrave, George S. Myers, S. A. Neave, the late C. D. Sherborn and Dr. E. Trewavas. Any views expressed in this paper are, however, my responsibility. Constructive criticism of this scheme would be welcome.

PRELIMINARY SAMPLE OF THE PROJECTED LIST OF GENERIC NAMES OF FISHES, ADDITIONAL TO THOSE IN JORDAN, 1963, IN ALPHABETICAL ORDER

To conserve space, citations show, at the most: (1) the generic name; (2) its author(s); (3) date (year) of publication; (4) reference, if not in standard nomenclators, with (5) type-species in parentheses ( ); (6) family name with the suffix-*(i)idae* omitted, or simply "foss." if the genus is fossil and of uncertain family; and (7) in the case of synonyms, the name regarded as a valid replacement, in square brackets, thus [=]; only primary synonyms are so noticed, since any others may be matters of opinion and liable to modification.

Lack of some rare books has prevented me from verifying or completing certain references.

There is considerable doubt whether the fossil Conodonts should be considered to have been fishes (it is not even certain whether they were vertebrates or invertebrates), so I have omitted them. A list of the genera of Conodonts has been supplied by Robert O. Fay, 1952, University of Kansas Paleont. Contrib., Vertebrata, Art 3: 60-206.

Nomina nuda, variant spellings, misprints, etc. are not listed. For example:

Ababes Gray, 1842, because it is a nomen nudum; *Abacion* Rafinesque, 1820, Annals of Nature 9, which is an insect, not a fish as indicated in Sherborn, 1932, Index. Anim. (2) 29, additions: 1; "*Abu*" and other names of Forskal, which may be in the Prussian Nomenclator Anim., 1926, but are not in Neave; and so on, down to *Zyrichthys* Swainson, 1839, a mere variant of *Xirichthys*.

Abantennarius Schultz, 1957. Antennar.
Abantis Jordan, 1925, foss. Carist. [Preocc. = Absalomichthys.]
Abcichthys Whitley, 1927. Scorpaen.
Abeichthys Parin, 1961. Exocoet.
Ablabys Kaup, 1873, Arch. Naturg., 39(1):80 (*taenionotus**) Scorpaen.
Abranches Smith, 1947. Gob.
Absalom Whitley, 1937. Carang.
Absalomichthys Whitley, 1933, foss. Carist.
Acahara Jordan & Hubbs, 1925. Cyprin.
Acanthalepis McCoy, 1846, foss.
Acanthapogon Fowler, 1938. Apogon.
Acanthocirrhitus Fowler, 1938. Cirrhit.
Acanthodes Fourmanoir & Crosnier, 1964, Cahiers Orstrom, 6: 23 (*fragilis*). Scorpaen. [Preocc. by Agassiz, 1846, in fossil sharks, and wants new name].

* Type-species, by present selection, *Apistus taenionotus* Cuvier & Valenciennes, 1829. *Ablabys* replaces *Amblyapistus* Bleeker, 1875. The only Australian species is *Ablabys* (*Parocosia*) *slacksmithi* (Whitley, 1958), comb. nov.

And so on, for perhaps five thousand names or more, down to . . .

Zonophichthus Whitley, 1930. Ophichthy.

Zoropsetta Jordan & Gilbert, 1920, Foss. Fish Lompoc :3, foss. Pleuronect. [= Zororhombus].

Zostericola Ilyin, 1927. Gob. [Preocc. = Zosterisessor].

Zostericola Berg, 1933. Gob. [Preocc. = Zosterisessor, *pace* Neave].

Zosterisessor Whitley, 1935. Gob.

Zu Walters & Fitch, 1960. Trachipter.

References.

Agassiz, L., 1846—Nomenclator Zoologicus, 1846, Index Universalis.

Berg, L. S., 1940—Classification of Fishes, both Recent and fossil. *Trav. Inst. Zool. Acad. Sci. URSS.,* 5 (2): 86-517, figs. 1-190.

Bleeker, P., 1862-1878—Atlas Ichthyologique, 9 vols.

Follett, W. I and L. J. Dempster, 1965.—Ichthyological . . . Names and Works on which the International Commission on Zoological Nomenclature has ruled . . . *Copeia,* 1965 (4): 518-523.

Fowler, H. W., 1964—A Catalog of World Fishes. *Q. J. Taiwan Mus.,* 17:1-62; later parts being issued.

Greenwood, P. H., 1964—Jordan's Fish Genera. *Nature,* 204, Oct. 3, 1964: 7.

Index Zoologicus, 1902-1912—Vol. 1, 1902 and 2, 1912.

Jordan, D. S., 1917-1920—The Genera of Fishes, 4 parts: 1-576.

————, 1923. A Classification of Fishes: 1-244.

————, 1963. The Genera of Fishes and A Classification of Fishes. Reprinted: 1-800.

Marschall, A. de, 1873—Nomenclator Zoologicus, Pisces: 61-98.

Munro, I. S. R., 1952—An application of visible indexing to Systematic Zoology. *Austr. J. Mar. freshw. Res.,* 3 (1): 92-100, figs. 1-4.

Neave, S. A., 1939-50—Nomenclator Zoologicus, vols. 1-5 and supplements (Vol. 6 was said to be in the press at the time of writing [1965]—G.P.W.).

Preussichen Akademie der Wissenschaften, 1926-1938—Nomenclator Animalium (Berlin), vols. 1-5, the last one never completed. Authors were the late F. E. Schultze, W. Kükenthal and K. Heider.

Rogers, J. S., 1953—Report of the Director. *Mus. Zool. Univ. Michigan,* 1951-1952: 25, fig. (Reproduction of card-form used in compilation of genera of fishes).

Scudder, S. H., 1882—Nomenclator Zoologicus, 1: 1-376 and 2: 1-340.

Sherborn, C. D., 1902—Index Animalium, 1758-1800.

————, 1922-1932—Index Animalium, 1801-1850, vols. 1-9, including addenda.

Weber, M. and L. F. de Beaufort, 1911—Fishes of the Indo-Australian Archipelago, 1. (Index of names in all Bleeker's works, except his *Atlas Ichthyologique*).

Zoological Record, 1864 to early 1960's. (Especially lists of genera at the end of each volume. Before 1870, there were no separate lists of new genera in the Zoological Record and no distinction was drawn between those of fishes and other animals until 1876. Emendations and substitute names began to be proposed in the 1872 volume and some of these were overlooked by other nomenclators. About the 1880's, examination of new names by the Recorders for possible preoccupation became superficial and, like their classical emendations, subsequently lapsed).

NOTES ON SOME QUEENSLAND FISHES

by G. P. Whitley

(Plates XIII-XIV, figures 1-5).

In May 1964, I spent some recreation leave at Karumba, on the Gulf of Carpentaria, Queensland, where, thanks to facilities afforded by Mr. Ian S. R. Munro, Project Leader of the Gulf Prawn Survey, I was able to see many interesting fishes which had been caught besides the prawns. Notes on a few of them are recorded here, also some on other Queensland fishes. Thanks are also due to Miss Helen Ashton for some of the illustrations.

Family GALEIDAE.

Genus GALEOLAMNA Owen, 1853.

Subgenus LAMNARIUS Whitley, 1943.

GALEOLAMNA (LAMNARIUS) SPENCERI (Ogilby).

(Figure 1.)

Carcharias spenceri Ogilby, 1911, Proc. Roy. Soc. Qld., 23(1):3. Brisbane River, Qld.

Galeolamna (*Lamnarius*) *spenceri* Whitley, 1943, Proc. Linn. Soc. N.S.Wales, 58: 119, fig. 3 (q.v. for refs.).

Carcharhinus spenceri Garrick & Schultz, 1963, Sharks and Survival: 35.

Eulamia spenceri Stead, 1963, Sharks and Rays Austr. Seas: 86 & 200.

Galeolamna spenceri Whitley, 1964, Rec. Austr. Mus., 26: 159.

This is a whaler shark with dental formula $\frac{12.1.12}{11.1.11}$, no interdorsal ridge, a bluntly rounded snout, no conspicuous colour-markings and general facies as figured here. The biometrics of the Karumba specimen described below agree well with example E in my 1943 table but the width of the mouth is only 66 mm. and the labial folds are minute. Head broadly rounded, 4.2 in total length, its profile rising convexly to the long-based first dorsal fin. Teeth in upper jaw typically as long as broad, not notched, hardly deflected, each with about 17 coarse serrae along each edge. Symphysial tooth minute, serrated in upper and entire in lower jaw. Teeth of lower jaw more erect and shouldered, serrated on shoulder and cusp. No conspicuous row of pores behind eye. Nostrils crescentic, with slight flap. Interorbital convex.

Body fairly robust, depth 6.5 in total length. Denticles crossed by 3 or 4 carinae. Preanal length less than postanal length. Caudal pit above and below. Interdorsal space greater than distance from eye to first dorsal origin. No interdorsal ridge. No umbilical scar. Snout to upper caudal pit, 505 mm.; upper caudal lobe, 221.

Pectoral angle reaches below anterior fifth of first dorsal base; no bite-marks. Origin and end of anal fin behind levels of those of second dorsal. 185 vertebrae, the 25th opposite origin of first dorsal fin; 51st opp. that of ventral fin; 65th opp. that of second dorsal fin; 69th opp. that of anal fin, and there are 88 to base of caudal.

Colour after death pale grey, slightly darker edges to fins; no dusky lateral streak. Eye silver with blue ring and pupil. Edge of dark dorsal colour passing over eye.

Described and figured from an immature female, 726mm. or 29 inches overall length. Stomach contained the pectoral girdle of a fish (*Polydactylus*) and the head of a prawn (*Metapenaeus*, probably *M. eboracensis*). Australian Museum regd. no. IB.7139.

Loc.—Karumba, Gulf of Carpentaria, Queensland; handline from beach, May 1964.

Figure 1—Whaler Shark, *Galeolamna* (*Lamnarius*) *spenceri*. Queensland. Inset: upper and lower tooth, denticle, and ventral view of head.

G. P. Whitley & H. Ashton del.

Family PLOTOSIDAE
Genus NEOSILURUS Steindachner, 1867.
NEOSILURUS BREVIDORSALIS (Gunther).
(Figure 2).

Copidoglanis brevidorsalis Gunther, 1867, Ann. Mag. Nat. Hist. (3)20: 66. Cape York, Queensland and Nicol Bay, W. Australia.
Id. Macleay, 1881, Proc. Linn. Soc. N.S.Wales 6:207; Cat. Austr. Fish. 2, 1882:143.
Id. Weber, 1913, Nova Guinea 9: 526, 527, 530, 532, 604 and 607 (Lorentz River, New Guinea).
Id. Weber and Beaufort, 1913, Fish. Indo-Austr. Archip. 2:241.

Neosilurus brevidorsalis Steindachner, 1867, Sitzungsb. Akad. Wiss. Wien 56(1): 319 (Cape York. Described). *Id.* Troschel, 1870, Archiv Naturges. (Weigmann) 36 (4): 276 Cape York. Sex-dimorphism. A female without ventral fins. But see Gunther, 1873, Zool. Rec. 1871, Pisces: 104, for discussion. *Id.* Ogilby, 1908, Ann. Q'ld. Mus. 9:14. *Id.* Weber, 1911, Abh. Senckenb. Naturf. Ges. 34:21 (Aru Islands). *Id.* Whitley, 1938, Rec. Austr. Mus. 20:223 (Upper Fly River, New Guinea). *Id.* Whitley, 1947, W.A. Nat. 1:53. *Id.* Whitley, 1957, Australasian Aqua Life 2(6):10. *Id.* Munro, 1957, Fisheries Newsletter, April 1957:16, Hbk. Austr. Fish. 10:42, no. 301.

Copidoglanis (Neosilurus) brevidorsalis Rendahl, 1922, Medd. Zool. Mus. Kristiania 5:172.

Tandanus (Neosilurus) brevidorsalis McCulloch and Whitley, 1925, Mem. Q'ld. Mus. 8(2):134. *Id.* McCulloch, 1929, Austr. Mus. Mem. 5:57.

The bibliography of this species is here assembled and it is figured for the first time from a Papuan specimen, from the Upper Fly River, 225 mm. (nearly 9 inches) long (Austr. Mus. regd. no. IA.7224).

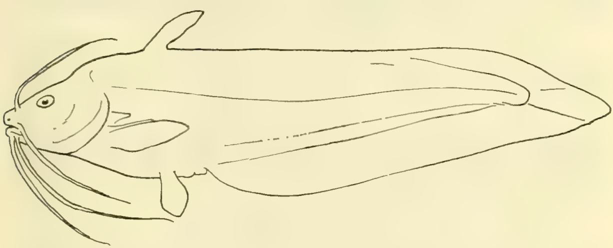


Figure 2—Catfish, *Neosilurus brevidorsalis*. Papuan specimen.
G. P. Whitley del.

Family SOLEIDAE.
Genus ASERAGGODES Kaup, 1858.
ASERAGGODES GUTTULATUS Kaup.

Aseraggodes guttulatus Kaup, 1858, Arch. Naturges., 24 (1): 103. No locality. *Id.* Chabanaud, 1927, Bull. Inst. Oceanogr. Monaco, 500: 14. *Id.* Chabanaud, 1930, Zool. Meded., 13: 185 & 190. *Id.* Chabanaud, 1931, Bull. Soc. Zool. France, 56: 302 & map. *Id.* Chabanaud, 1939, Bull. Inst. Oceanogr. Monaco, 763:20.

Solea guttulata Gunther, 1862, Cat. Fish. Brit. Mus., 4: 477.

Solea kaiana Gunther, 1880, Rept. Voy. Challenger, Zool., 1 (6): 49, pl. 21, fig. c. Kai Islands, 129 fathoms. *Id.* Gunther, 1887, Rept. Voy. Challenger, Zool., 22: 167. *Id.* Kamohara, 1934, Zool. Mag., 46: 462.

Aseraggodes kaianus Weber & Beaufort, 1929, Fish. Indo-Austr. Archip., 5: 152, 155 & 429. *Id.* Kamohara, 1939, Bottom-fishes Prov. Tosa :61-62. *Id.* Kamohara, 1952, Rept. Kochi Univ. Nat. Sci. (3): 84. *Id.* Ochiai, 1964, Faun. Japon., Soleina: 9, 20 & 32, pl. 10, text-figs. 10, 15-16.

Several examples from the Gulf of Carpentaria, netted by the Gulf Prawn Survey. One (regd. no. IB.7212) in Australian Museum.

New record for Australia.

Genus STRABOZEBRIAS Chabanaud, 1943.

Strabozebrias Chabanaud, 1943, Bull. Mus. Hist. nat. Paris, (2) 15: 293. Type-species, *Synaptura cancellata* McCulloch. Also includes *S. craticula* McCulloch.

STRABOZEBRIAS MUNROI, sp. nov.

(Plate xiii)

D.68; A.58; P. (left) 8, (right) 5; V.3; C.15. L.lat. 93 on eyed and 100 on blind side. L.tr. 30/1/35 on eyed side, 40/1/40 on blind side.

Head (19 mm.) 4.7, depth of body (40) 2.27 in standard length (91). Eye (3) 6.3, snout (5) nearly 4, length of pectoral (1) 19 and length of caudal (16) 1.18 in head.

Snout not hooked, snub-nosed, chin prominent. Mouth shorter and more curved on blind side; lips entire, somewhat contorted. Eyes small, dextral, contiguous, without any scaly interspace but with a common translucent palpebral epidermis, the upper eye partly in advance of the lower. Nostril tubes simple, short. Gill-openings restricted.

Body covered with imbricate, strongly ctenoid scales on both sides, without cutaneous flaps. Scales of head same size as body-scales. Nine grooves in l.lat. scale. Dorsolateral line absent.

Origin of dorsal fin on front of head before eyes, its first ray not produced. Dorsal and anal rays simple, the last completely confluent with the caudal. Pectorals vestigial on both sides, that on the blind side longer than the other. Left ventral fin reduced, near vent. Right ventral connected with first anal ray.

Ground-colour cream or very pale yellow becoming white on the fins. Head and body (on eyed side) partly or entirely crossed by nine to twelve very irregularly shaped fawny-brown bars, the interior areas of which are lighter in tone, more like the ground-colour. These bars extend over the unpaired fins and become darkest brown above and below the tail-fin which is mostly white. Blind side pale yellow with the dark areas of the dorsal and anal fins showing through. Pectoral fins white. Eyes blue.

Described from the holotype, a specimen 91 mm. in standard length or 4½ inches overall. Australian Museum regd. no. IB.7210. Three paratypes, up to 5.3 inches in length, in the Gulf of Carpentaria Prawn Survey collection (Cat. no. 304) show no noteworthy variation apart from the colour-bars which are of different configuration in each.

Loc.— "Rama" trawl station no. 398, south-eastern corner of the Gulf of Carpentaria, Queensland: Lat. 17°32'20" S. by Long. 140°33'35" E., in 2½ fathoms. 26 November 1963.

The striking colour-markings and the largely white caudal fin are diagnostic. Can be added to the bottom of Norman's key* to "*Brachirus*" by appending: C. Head less than 5 in length. Nine to twelve irregular cross-bars. Tail mostly white .... *Strabozebrias munroi*.

Named in appreciation of Mr. Ian S. R. Munro, Project Leader of the Gulf of Carpentaria Prawn Survey, most of whose collections are now housed in the Australian Museum, Sydney.

*Norman, 1926, Biol. Res. Endeavour, 5(5):292.

Family CALLYODONTIDAE.
Genus CALLYODON Scopoli, 1777.
CALLYODON TOSHI (Whitley).
(Figure 3).

Heteroscarus sp. Tosh, 1903, Parl. Rept. Mar. Dept. Qld. 1902-03: 20 & 23 (misprinted *Pecudoscarus*), pl. vi, fig. 3. Southport, Moreton Bay, Queensland, 12 inches long.

Callyodon cyanotaenia Ogilby, 1915, Mem. Qld. Mus. 3: 135. Not *Scarus cyanotaenia* Bleeker, 1854, Nat. Tijdschr. Ned. Ind. 6: 197, from Batavia which is a *Xanothon*.

Scarus sp. and *S. cyanotaenia* McCulloch and Whitley, 1925, Mem. Qld. Mus. 8: 169.

Scarus toshi Whitley, 1933, Rec. Austr. Mus. 19: 61. Southport, Queensland. *Id.* Schultz, 1958, U.S. Nat. Mus. Bull. 214: 12.

Callyodon toshi Whitley, 1964, Rec. Austr. Mus., 26 (5): 150.

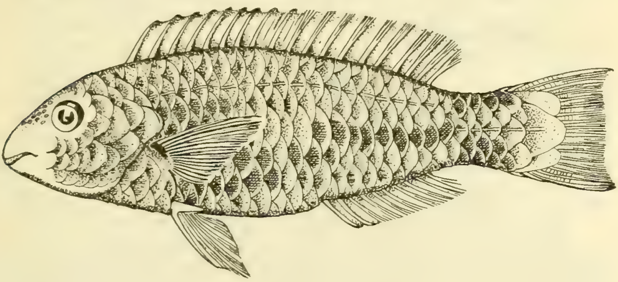


Figure 3—Parrot Fish, *Callyodon toshi*. Queensland.
Helen Ashton del.

Here illustrated from a specimen, 148 mm. in standard length and 7 inches overall, from Gillett Cay, Swain Reefs, Queensland. (Aust. Mus. Expedition, October, 1962). Austr. Mus. regd. no. IB.6086.

Family CHAMPSODONTIDAE.
Genus CHAMPSODON Gunther, 1867.
CHAMPSODON NUDIVITTIS (Ogilby).

Centropercis nudivittis Ogilby, 1895, Proc. Linn. Soc. N.S.Wales, (2) 10: 320. Maroubra, New South Wales.

Two examples of this species were trawled by Mr. T. Nielsen from 100 fathoms, off Cape Moreton (Austr. Mus. regd. nos. IB.7062-3).

New record for Queensland.

Family OPISTOGNATHIDAE.
MEROGYMNOIDES, gen. nov.

Type-species, *Merogymnoides carpentariae*, sp. nov.

Diagnosis: A genus of Jawfishes with large scales which extend forward on the body to leave only small areas of the breast naked. The head is scaleless. Gill-rakers on first branchial arch 31. Maxillary shorter than head, its distal end truncate.

The dorsal spines are weak and flexible, not split. There is one anal spine and twelve rays and thirteen dorsal rays. Body without conspicuous markings.

Key to Genera of Opistognathidae.

A. Dorsal spines pungent, cheeks and opercles with scales.
  B. Scales about 30 to 40 in longitudinal series.
    C. Gill rakers 38 on first gill-arch. Anal fin with 2 spines. Dorsal and anal with about 12 rays each .... *Lonchistium* Myers, 1935.
    CC. Gill rakers 28. Anal fin with 3 spines. Dosal and anal rays 14 .... *Upsilonognathus* Fowler, 1946.
  BB. Scales over 55. Gill-rakers 64. Anal with 3 spines. Dorsal and anal with 16 to 18 soft rays .... *Lonchopisthus* Gill, 1862.
AA. Dorsal spines flexible, cheeks and opercles naked.
  D. Dorsal spines distally split into two lateral segments *Stalix* Jordan & Snyder, 1902.
  DD. Dorsal spines distally entire.
    E. Trunk naked anteriorly.
      F. Scales small and very numerous, not extending forward to pectoral base .... *Merogymnus* Ogilby, 1908.
      FF. Scales in about 50 rows or less, extending much farther forward .... *Merogymnoides*, gen. nov.
    EE. Trunk fully scaled.
      G. Maxillary shorter than head, its distal end truncate or notched.
        H. Eight dorsal spines .... *Gnathypops* Gill, 1862.
        HH. More than eight dorsal spines .... *Tandya* Whitley, 1930.
      GG. Maxillary greatly produced backward in a flexible lamella, about as long as head *Opistognathus* Cuvier, 1816.

MEROGYMNOIDES CARPENTARIAE, sp. nov.
(Figure 4)

Br. 6. D. x, 13; A. i, 12; P.i, 19; V. i, 4; C. 16 main rays. L. lat. 25? Sc. *c.* 50. Tr. 3/1/20 to 10 on caudal peduncle. Predorsal scales 4. Gill-rakers 11 + 20 on first branchial arch.

Head (25 mm.) 2.7, depth (20) 3.4 in standard length (68). Eye (7) 3.5. Maxillary (14) 1.7 in head. Interorbital (2) 3.5 in eye and half depth of distal end of maxillary (4). Length of pectoral fin, 13 mm; length of ventral fin, 15. Width of body, 11. Least depth of caudal peduncle, 9.

Head about as wide as deep, profile humped over eyes. Snout much less than eye. Interorbital narrow, apparently without pores. Pores across vertex of head. Preoperculum without spine. Two opercular spines. Nostrils without tube. Gill-membranes united across narrow isthmus. Head naked.

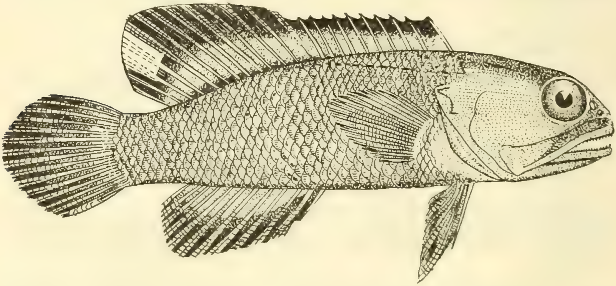


Figure 4—Jawfish, *Merogymnoides carpentariae*. Holotype. Queensland.
Helen Ashton del.

Maxillary shorter than head, truncate, extending a short distance behind eye. A single row of spaced teeth around each jaw. A hooked canine on each side of symphysis of upper jaw, with several smaller teeth, behind the uniserial outer teeth. Dental formula $\frac{34.34}{25.25}$, teeth not villiform. Vomer and palatines with only vestiges of teeth.

Trunk mostly naked in advance of a line joining pectoral base to origin of ventral fin. Body scales imbricate, cycloid. Lateral line near the back, reaching to beyond middle of dorsal fin-base, with about 25 tubes, terminating below first to fourth dorsal rays.

Dorsal spines weak, flexible, lower than rays, not split distally. Fins all rounded except for ventrals which are pointed and do not reach vent.

General colour, after preservation, pale yellowish-brown, becoming darker brown on top of head and over gill-openings and branchiostegal region. Eyes blue. Orbit almost surrounded by brown ring. No conspicuous dark "moustache"—mark at maxillary. A dusky symphysial blotch. Paired fins light brown. Unpaired fins mostly blackish, the dorsal with a median cream band, the anal with a basal one.

Described and figured from the holotype specimen, 83 mm. or 3¼ inches long, one of two examples obtained in 1964 by the C.S.I.R.O. Gulf Prawn Survey. Australian Museum registered no. IB.7145. Paratype in C.S.I.R.O. collection.

Locality—Gulf of Carpentaria, Queensland.

Apparently nearest *Merogymnus eximius* Ogilby, 1908, but differing in the following salient characters:—

A. Scales extend forward on the trunk to below the middle of the adpressed pectorals; they are small and very numerous. L.lat. with about 80 tubes. Body with large golden spots. Gill-rakers 26 on lower portion of first branchial arch .. *Merogymnus eximius.*

AA. Scales extend much farther forward, leaving only a small portion of breast naked. L.lat. with less than 30 tubes; scales on body larger and fewer, in about 50 transverse rows. Body without large golden spots. Gill-rakers 20 on lower portion of first branchial arch .... *Merogymnoides carpentariae,* gen. et sp. nov.

"Opisthognathus" versluysi Weber, 1913, from Indonesia, differs in formulae, proportions and coloration, and so does *Gnathypops evermanni* Jordan & Snyder, 1902, from Japan, which is superficially similar; the latter species has recently been figured from Vietnam by Fourmanoir (1965, Cahiers O.R.S.T.O.M., spec. no., p. 75, fig. 48). *Opisthognathus macrolepis* Peters, 1866, from Bangkok, has more fin-rays and scales and slenderer build.

Family CONGROGADIDAE.

Genus CONGROGADOIDES Borodin, 1933.

CONGROGADOIDES SPINIFER Borodin.

(Figure 5)

Congrogadus spinifer Borodin, 1933, Ann. Rept. Direct. Mus. Comp. Zool., 1932-33: 45. Australia. Nomen nudum.

Congrogadoides spinifer Borodin, 1933, Copeia, 1933 (3): 141. Broome, W. Austr. *Id.* Whitley, 1964, Austr. Nat. 12 (4): 8 (Darwin, N. T.). *Id.* Smith, 1952, Ann. Mag. Nat. Hist. (12) 5:85.

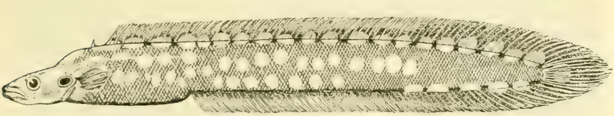


Figure 5—Dagger Fish, *Congrogadoides spinifer.* Queensland.
Helen Ashton del.

Here figured for the first time from a specimen (Austr. Mus. regd. no. IB.6931), taken from a large sponge, trawled about 18 miles N.E. of the mouth of the Albert River, Gulf of Carpentaria, Queensland; 7th Dec. 1963: collected by Drs. J. Yaldwyn and D. F. McMichael. Total length 145 mm. or 5.7 inches.

The species is known from north-western Australia, across the Northern Territory to Queensland.

Family GOBIOMORIDAE.

Genus PRIONOBUTIS Bleeker, 1874.

PRIONOBUTIS MICROPS (Weber).

Pogoneleotris microps Weber, 1908, Nova Guinea, 5: 258, pl. 12, figs. 4a and 4b. Tawarin & Merauke Rivers, New Guinea.

Two specimens (Austr. Mus. regd. nos. 6883 & 7148) from the Gulf of Carpentaria.

New record for Queensland.

Family BATHYAPLOACTIDAE.

Bathyaploactinae Whitley, 1933, Rec. Austr. Mus. 19: 102. Bathyaploactidae Beaufort, 1962, Fish. Indo-Austr. Archip. 11: 91.

KARUMBA, gen. nov.

Type-species—*Bathyaploactis curtisensis ornatissimus* Whitley, 1933, but not the nominate species, *B. c. curtisensis.*

Differs from all other genera of the family (*Bathyaploactis* Whitley, 1933, *Acanthosphex* Fowler, 1938, and *Kleiwegia* Beaufort, 1952) in having four, pungent anal spines, instead of fewer, weak ones. The gill-opening extends to below the preopercular margin. Other characters are as defined for the family by the above authors, and as described for the species below. Very few fishes have four anal spines: the South African Scorpaenid, *Sebastosemus,* sometimes has four, but the insertion of its dorsal fin and many other characters are quite different from this novelty.

KARUMBA ORNATISSIMA (Whitley).

(Plate xiv)

Bathyaploactis curtisensis ornatissimus Whitley, 1933, Rec. Austr. Mus. 19: 103, pl. xiii, fig. 2. North-western Australia.

D. xiv, 7; A. iv, 6; P. 11; V. i, 2; C. 12. L.lat. about 8 tubes.

Head (18 mm.) 2.6, depth (17) 2.8 in standard length (48).

Head compressed, with no deep pits or grooves. An inconspicuous barbel each side of chin and a row of papillae. Lower jaw terminal. Maxilla truncate, reaching below front of eye. Teeth in fairly broad villiform bands on both jaws and vomer, but not on palatines. Mouth oblique. Tongue bluntly rounded, free. One bony, blunt-tipped upper and a short lower preorbital spine. Suborbital stay smooth. Eye lateral, united with skin of head. Interorbital narrow, three-crested. Preoperculum with four prominent blunt spines. Head ending in two lobes, each with a weak opercular spine. No spines on top of head or shoulders. Gill-opening extending forward to below preopercular margin; isthmus broad. Seven, round, pad-like gill-rakers on first branchial arch.

Deep and compressed, width about ½ depth. Body smooth with rudimentary scales apparent below epidermis. Lateral line with about eight tubes, the posterior ones with small skinny flaps. No papillae or tentacles. Lateral line gently curved anteriorly, highest below 5th or 6th dorsal spines, thence running along side of tail, consisting of 8 tubes without spines. Caudal peduncle longer below than above.

Dorsal fin originating over eye, with 14 strong spines, 2nd to 3rd longest, membranes incised. Rays longer, simple, articulated. Last dorsal ray joined to caudal peduncle immediately before caudal fin. Last anal ray before this. Anal with four spines and six soft rays, its origin below 12th dorsal spine, its fourth spine longest, shorter than rays, of which 3rd is longest. Pectoral with subvertical base. 11 simple rays, fifth from top longest and almost reaching

soft dorsal and anal fins; margin of fin rounded, membranes incised, no detached lower ray. Ventral below opercular flap, with a strong spine whose length is nearly half that of head, and two simple rays, the first longer. Caudal rounded, with 12 simple rays, longest subequal to head.

Colour in formalin, white, densely mottled with irregular light brown markings which tend to form crossbars on interorbital and below spinous dorsal fin. Lower surface of head and belly white. The darkest markings are almost blackish and occur on the fins: notably the middle of the first dorsal, the second dorsal and anal and the edges of the pectorals, ventrals and caudal. Eye blue. Pectoral axil plain.

Described and figured from a specimen 2½ inches overall in the collection of the Gulf Prawn Survey, Karumba, Queensland. A smaller one (no. IB.7143) in Australian Museum with same data.

Locality—Gulf of Carpentaria, Queensland; Haul 452 = S.E. of Bentinck Island, ½ way to Nicholson R., Q. 3½ fathoms. (C.S.I.R.O. Gulf Prawn Survey).

New record for Queensland.

Explanation of Plates

Plate xiii—Sole, *Strabozebrias munroi*. Holotype. Queensland.
Photo:— C. V. Turner,
Australian Museum.

Plate xiv—Wasp Fish, *Karumba ornatissima*. Queensland.
G. P. Whitley del.

THE GENERA OF THE GALAXIIDAE

by E. O. G. Scott

INTRODUCTION

In a paper (1965, unpublished) presented at the 38th Congress of the Australian and New Zealand Association for the Advancement of Science, at Hobart, a general survey of the current position in Galaxiid systematics was made in four sections: I. Relationships of the family; II. Family and sub-family characters; III. Genera and subgenera; IV. Species and subspecies. The present contribution represents the gist of III; detailed biometric evidence in support of some of the conclusions here advanced that differ from accepted concepts will, it is hoped, appear elsewhere; some remarks on convergent and divergent evolution that follow the itemised treatment of the published genera extend on to some of the ground covered in II.

PART I. — REVIEW OF THE GENERA

Fishes now placed in the Galaxiidae that have at some time been referred to other families include *Galaxias argenteus* (Gmelin, 1789), the apparently conspecific *G. alepidotus* (Bloch & Schneider, 1801), *G. truttaceus* (Cuvier, [1816]), all originally placed in *Esox* Linné, 1758 (Esocidae, Clupeiformes); *G. variegatus* (Lesson, 1830), described under *Stomias* Schinz, 1822 (Stomiatidae, Clupeiformes); *Agalaxis zebratus* (Castelnau, 1861), *A. punctifer* (Castelnau, 1861), both relegated by their describer to *Cobitis* Linné, 1758 (Cobitidae, Cypriniformes). *Galaxias indicus* Day, 1888, from near Bengal and Madras, is stated not to be a Galaxiid.

Genera and subgenera proposed within the Galaxiidae are as follows:

I. *Galaxias* Cuvier, (1816), Règne Anim., ed. 1, ii:183. Haplotype *Esox truttaceus* Cuvier, (1816). (The relevant volume, dated 1817, appears to have been published in December 1816).

I (a) Subgenus *Galaxias* Scott, 1936, *Pap. Proc. Roy. Soc. Tasm.* (1935): 88. Orthotype *Esox truttaceus* Cuvier, (1816).

I (b) Subgenus *Agalaxis* Scott, 1936, *ibid.*, :105. Orthotype *Cobitis zebratus* Castelnau, 1861. (See genus XII).

II. *Mesites* Jenyns, 1842, *Zool. Voy. Beagle, Fish.*, iv: 118. Logotype *Mesites attenuatus* Jenyns, 1842. Preoccupied by *Mesites* Schonherr, 1838 (Coleoptera).

III. *Neochanna* Günther, 1867, *Ann. Mag. Nat. Hist.* (3), XX:305. Haplotype *Neochanna apoda* Günther, 1867.

IV. *Austrocobitis* Ogilby, 1899, *Proc. Linn. Soc. N.S.W.*, xxiv:158. Substitute for *Mesites* Jenyns, 1842, preoccupied. Logotype *Mesites attenuatus* Jenyns, 1842.

V. *Brachygalaxias* Eigenmann, 1928, *Mem. Nat. Acad. Sci. Washington,* xxii:49. Haplotype *Galaxias bullocki* Regan, 1908.

VI. *Paragalaxias* Scott, 1935, *Pap. Proc. Roy. Soc. Tasm.* (1934):41. Orthotype *Paragalaxias shannonensis* Scott, 1935.

VII. *Nesogalaxias* Whitley, 1935, *Vict. Nat.*, lii, 3:42. Logotype *Galaxias neo-caledonicus* Weber & De Beaufort, 1913. (Trivial name rendered there, as by most authors, *neocaledonicus*).

VIII. *Lyragalaxias* Whitley, 1935, *ibid.;* pl. iii, fig. 5. Logotype *Galaxias o'connori* Ogilby, 1912. (Trivial name rendered there, as by most authors, *oconnori*).

IX. *Querigalaxias* Whitley, 1935, *ibid.;* pl. iii, fig. 9. Logotype *Galaxias dissimilis* Regan, 1906.

X. *Saxilaga* Scott, 1936, *Pap. Proc. Roy. Soc. Tasm.* (1935):105. Orthotype *Galaxias cleaveri* Scott, 1934.

X. (a) Subgenus *Saxilaga* Scott, 1936, ibid. :106. Orthotype *Galaxias cleaveri* Scott, 1934

X. (a). Subgenus *Saxilaga* Scott, 1936, *ibid.* :106. Orthotype *Galaxias cleaveri* Scott, 1934.

(b). Subgenus *Lixagasa* Scott, 1936, *ibid.* :110. Orthotype, *Galaxias burrowsius* Phillipps, 1926.

XI. *Lepidogalaxias* Mees, 1961, *Journ. Roy. Soc. W. Aust.*, 44, 2: 33, fig. 1, pl. I, II.

XII. *Agalaxis.* This subgenus of *Galaxias* (I[a]) is here given full generic status.

GENUS I — *GALAXIAS* CUVIER, (1816)

Galaxias stands as the foundation genus of the family; and calls for no special comment here.

SUBGENERA I (a) *GALAXIAS,* I (b) *AGALAXIS*

In his revision of the Galaxiidae, for which he had available nearly two hundred specimens, Regan (1906) noted 23 species as having the pelvic 7-rayed, 3 (the 2 South African species and his *Galaxias dissimilis,* described in this paper) as having it 6-rayed; no intraspecific variation being recorded. In a paper containing a synoptic survey of established and new taxons Scott (1936), making free use of reported ray counts, suggested, *inter alia,* two subgenera, *Agalaxis* (for South African forms: *G. dissimilis* referred to subfamily Paragalaxiinae) differing from the typical subgenus in having 6, instead of 7, pelvic rays. However, it has since been demonstrated by Stokell (1940, 1945) that the pelvic count (a specific, even generic, constant in most teleosts) is subject in the present family to considerable individual variation, even to the extent of disparity in fins of the same fish (a condition not unusual in many fishes in the other paired fin). The original diagnoses of the subgenera, based solely on the criteria of 7 or 6 pelvic rays, are hence clearly invalid. Nevertheless, it remains true that the forms concerned are separable into two groups, coextensive with the proposed subgenera, one group having a modal pelvic ray number of 7 (a mode of 6 has been reported for the type material of *Galaxias divergens* Stokell, 1959), the other a modal pelvic ray number of 6. (It may be observed, in passing, that counts of 5 and 8, reported by Stokell, would formally exclude fish exhibiting them, not only from the proposed subgenera, but also from the family as defined by Regan). Moreover, the South African forms that constituted the subgenus *Agalaxis* are now known (Barnard, 1943) to differ in features other than pelvic formula from typical *Galaxias.* They have been referred by Stokell (1950) to *Paragalaxias.* Reasons are adduced below for regarding this action as unwarranted, and it is here proposed they should remain in (and continue to constitute) *Agalaxis,* which is now to be elevated to a genus. The subgenus *Galaxias* thus comes to be abandoned.

GENUS II. *MESITES* JENYNS, 1842.

Mesites—comprising *M. attenuatus* (the one widely ranging Galaxiid); *M. maculatus, M. alpinus,* both from Tierra del Fuego; all three newly described from *Beagle* material—was established without formal distinction from, and apparently in ignorance of Cuvier's *Galaxias. Mesites* falls, preoccupied: for the status of some species referred to it see *Austrocobitis,* below.

GENUS III. *NEOCHANNA* GUNTHER, 1867

Of the characters by which *Neochanna* was originally distinguished from *Galaxias*—(a) no pelvics, (b) teeth in jaws compressed, (c) palate toothless [Berg (1940)—American-issued edition in Russian and English, 1947 seen; Berg's 1955 paper in Russian is not available to the writer—who cites Regan (1913:289) is in error in specifying for his order Galaxiiformes "entopterygoid toothed"], (d) pyloric appendage single, (e) gill-rakers widely set—only (a) and possibly (c) remain valid, (c) falling if *Saxilaga* possesses an edentulous palate and is subsumed in *Galaxias.* [The "palatine bone" of Günther (1866), dentigerous in most Galaxiids, is commonly spoken of as the entopterygoid: by Regan (1913; not 1906), Chapman (1944), Gosline (1960) and some others it is identified as the mesopterygoid]. Neither (b) nor (e) holds for *N. diversus* Stokell, 1949; while as for (d) 2 caeca have been found (Stokell, 1945:138) in *N. apoda* and 0, 1, 2, 3 (with intraspecific variation) occur in *Galaxias.*

A distinction that has not hitherto received notice is provided by the main caudal rays, which in *Neochanna* (at any rate in *N. apoda*) are variable in number, with a tendency to be fewer than in *Galaxias*. In species of *Galaxias* examined there regularly occur, in addition to a variable number of short and procurrent rays, 14 branched rays, flanked above and below by one large unbranched ray (as an occasional individual variation, a normally simple ray may exhibit incipient division, other minor variations possibly occur.) A count of branched rays in British Museum specimens of *Neochanna apoda* gave 12 (Dr. P. H. Greenwood, *in litt.*); 7 examples in the Dominion Museum, Wellington were found (Mr. J. Moreland, *in litt.*) to possess 12 (2 individuals), 13 (3), 14 (2). Gosline (1960) has shown the caudal skeleton, including the quota of branched rays, is of considerable diagnostic importance in the isospondylous fishes studied by him, and it may well be that in Galaxiid genera the ray pattern is of taxonomic value. The arrangement exhibited by *Galaxias* is presumably the primitive one, divergences from it (all so far observed reductions) representing specialisations.

GENUS IV. *AUSTROCOBITIS* Ogilby, 1899

In concluding his description of *Galaxias occidentalis* from Western Australia Ogilby (1899:158) observed it "belongs to the group of which *Mesites attenuatus* is the type, and which differs from the typical *Galaxias* (type *alepidotus*) in its slender subterete or slightly compressed body, small head which is as wide or a little wider than deep, small mouth, fewer (six or seven) branchiostegals, small fins and emarginate caudal"; and he suggests *Austrocobitis* (substitute for *Mesites* Jenyns, preoccupied) for this group. While Ogilby's species certainly departs noticeably in general facies from *G. alepidotus* (probably = *G. argenteus*), the latter is itself neither morphologically central in, nor formally typical of, *Galaxias;* and an analysis of the features of the Western Australian fish yields no good reason for regarding it as other than congeneric with the general corpus of Australian species referred to that genus.

Austrocobitis has been rejected by Regan (1906), Stokell (1945)—the latter's discussion being weakened by comparative citation of two species not belonging to *Galaxias s. str.*—and by most Australian authors, *e.g.,* Waite (1921), Lord & Scott (1924), McCulloch (1929), Mack (1936), Munro (1957), Scott (1960); but is retained by Whitley, though in a form other than that accepted by Ogilby (*G. occidentalis* being excluded), and in a more restricted sense than the original connotation of *Mesites* (including only the type species, *M. attentuatus*). *Austrocobitis* "differs from *Galaxias* in having 12 to 15 branched rays in the anal fin intsead of a less number, and more than 60 vertebrae" (Whitley, 1960:28). The large complement of branched rays is indeed not fully matched elsewhere, though Jenyn's other two species have 11-14, 12-13 (Regan, 1906), while counts of 12 have been reported for various species (e.g., *G. truttaceus, G. fasciatus, G. argenteus*): among Australian species of *Galaxias s. str. G. findlayi* possesses 60-61 vertebrae, while extralimital forms with high counts include *G. fasciatus* 61, *G. brevipinnis* 64 (Regan, 1906) or 59-62 (Stokell, 1954), *G. campbelli* 59-64.

The Australian representative is now listed by Whitley (1964:35) as *Austrocobitis attenuatus scriba* (Cuvier & Valenciennes, 1846).

GENUS V. *BRACHYGALAXIAS* Eigenmann, 1928

Eigenmann's genus, established for *G. bullocki* Regan, 1908 from Chile, the only Galaxiid then known with anal origin regularly cephalad of dorsal origin, was expressly rejected by Mack (1936:101) and Stokell (1945:134) and was not accepted by Shipway (1953:176): it was held in suspense by Scott (1936:88). However, examination of a paratype of Mack's *Galaxias pusillus* led the last-named (1942:55) to refer it to *Brachygalaxias*, and to call attention to seven points of agreement between the Victorian and Chilean fishes: (a) pelvic with fewer than 7 rays, (b) anal situated partly in front of dorsal, (c) vent located about at beginning of last third of standard length, (d) small size, (e) large eye, (f) longitudinal colour pattern, (g) small number of myomeres (*B. bullocki ca* 39, B. *pusillus* ca 38: earliest notice of this feature). Later, apparently independently, Stokell (1954:411) arrived at the same conclusion

of congenericity, adding as points of agreement (h) presence of keel between pelvic base and vent, (i) low egg number, and substituting for myomere count the more satisfactory feature number of vertebrae. *Brachygalaxias* would appear to be securely established: most recent Australian authors accept it (*e.g.*, Munro, 1957, Whitley, 1964), though Mees (1961) preferred not to give an opinion as to its validity.

The function of the characteristic keel—reminiscent of, though less pronounced than, the keel in the Retropinnidae (a family associated with Galaxiidae and Haplochitonidae to form Gosline's "southern group" of Osmeroidae)—remains unknown. The structure varies considerably in development, extending through almost the full pelvic-anal interval in *B. pusillus* (Mack, 1936) and in an undescribed Tasmanian form, but exhibiting significant elevation only in the hinder half of that interval in *B. nigrostriatus* (Shipway, 1953) and in another (undescribed) Western Australian species: in the genotype the ridge attains its full, quite moderate height in the last one-fourth or one-third of the short space between fin origins, lying behind tips of pelvics. It does not seem to have been remarked upon that some individuals of *Galaxias attenuatus* possess quite a pronounced keel running forward from just in advance of the vent and at times extending one-fourth of the distance towards pelvic base.

Of the 9 lettered items above (b) and (h) are constant within *Brachygalaxias*, and occur elsewhere only as an individual variation (as regards (b) this arrangement is noted (Stokell, 1949:495) for some examples of *Neochanna diversus*, and in a series of 20 South African Galaxiids, labelled as 10 of each species, received by the Queen Victoria Museum, Launceston from the South African Museum, Cape Town, there are 2 individuals with anal slightly earlier than dorsal; as regards (*h*), see preceding paragraph); (*f*) is paralleled (in so far as some markings are longitudinal; the patterns differing) only in *Lepidogalaxias* (which, however, may not belong to the Galaxiidae; see below); (*a*) is shared (as a norm) with all genera with pelvics except *Galaxias* (a mode of 6 is reported in the type material of *G. divergens* Stokell, 1959), (*d*), (*e*), (*g*), (*i*) with *Paragalaxias* and *Agalaxis* (*Lepidogalaxias*: (*d*), not (*e*), no data for (*g*), (*i*)), and (*c*) with *Agalaxis, Lepidogalaxias*.

Caudal ray patterns are unstable (see Part II), the number of branched rays in four species being as follows: in 10 British Museum examples of *B. bullocki* 11(2), 12(3), 13(3), 14(2) (Dr. P. H. Greenwood, *in litt*); in figure of holotype of *B. pusillus* 9, in material examined by the writer 8-10; in 8 specimens of an undescribed Western Australian species 10(7), 11(1); in 63 individuals of an undescribed Tasmanian form 5(1), 6(2), 7(3), 8(12), 9(30), 10(14), 11(0), 12(1), the series providing 14 numerically, 28 spatially, different combinations of simple, once-branched, twice-branched, partly twice-branched rays.

GENUS VI. *PARAGALAXIAS* Scott, 1935

To facilitate the discussion it is expedient to reproduce here the original diagnosis: "Differs from *Galaxias* and *Neochanna* in having the teeth in the jaws biserial; also differs from the members of both genera except *Galaxias dissimilis* Regan (see *Remarks*), in having the dorsal fin inserted well forward, at about level of ventrals. Vertebrae fewer than in other members of the family. Ventrals six-rayed. Size apparently small." The type material of the orthotype, *P. shannonensis*, was collected in the fast-running stretch of the Shannon River, about half a mile long, between Great Lake and Shannon Lagoon, Westmoreland/Cumberland, Tasmania (for ecological features of habitat see Tillyard (1933)): species known to occur also in Shannon Lagoon, Great Lake, Arthur's Lakes (unpublished data).

The genus has had a chequered history; to which the present communication adds a chapter: noteworthy events include the following. 1906 Regan described from a unique holotype (origin unknown; Regan gave New South Wales?, possibly because the specimen was received from the Australian Museum, Sydney; Queensland, Tasmania since suggested) *Galaxias dissimilis*, trenchantly separated from Galaxiids then known by having dorsal origin above the (6-rayed) pelvic. 1921 McCulloch (p. 28) remarked Regan's fish

"is perhaps merely an abnormal specimen." 1933 Whitley made available (pl. xii, fig. 2) a sketch by Regan. 1935 *Paragalaxias* established. 1935 Whitley proposed *Querigalaxias* for *G. dissimilis,* without diagnosis, but with reproduction (pl. iii, fig. 9) of Regan's sketch, 1936 Scott proposed subfamily Paragalaxiinae for *P. shannonensis* and Regan's species, the generic status of the latter remaining in doubt, an examination of the holotype, made by J. R. Norman at Scott's request, having found teeth in the jaws to be in a single series (leaving, at this stage, *Querigalaxias,* when formally completed, available for *G. dissimilis*). 1940 Phillipps (p. 39), apparently by a *lapsus calami,* referred to *Paragalaxias* his *Galaxias burrowsius* (trivial name emended (1927:11) to *burrowsii*: species made type (Scott, 1936) of subgenus *Lixagasa* of genus *Saxilaga*). 1942 attention was drawn to Phillipps' action (Scott :55). 1943 Barnard rendered non-significant two important points in the original diagnoses of *Paragalaxias* and the Paragalaxiinae, first, by reporting the existence in the Southern African Galaxiids referred in Scott's key (1936:87) to *Galaxias* (*Agalaxis*), Galaxiinae, of a low vertebral count (his figures (39) 40 (41)); secondly, by showing that in the fish examined by him (and, as Stokell subsequently reported (1950:1) in *Neochanna apoda* and five New Zealand species of *Galaxias* investigated by Barnard at his request) an additional row of teeth (decumbent; interpreted as a replacer row) occurs in the jaws (there are also extra lingual and pterygoidal rows), their presence being rendered apparent by the use of a clearing agent (one was employed in the original examination of *P. shannonensis;* unpublished item), thus making it evident that the traditional specification of teeth in the jaws of *Galaxias* as uniserial is to be taken as referring to erect functional teeth only, and that the description of a biserial dentition in *Paragalaxias* mistakenly directed attention to the normal second, decumbent row as a novel feature. 1945 Stokell observed of Regan's species "the single specimen on which it is based appears to be a deformed one" (p. 128), and in a schedule of genera and subgenera (p. 134) listed *Paragalaxias* under a heading "Genus Excluded from the Galaxiidae." 1950 in a revision of *Paragalaxias* the same author (*a*) reinstated this genus in the Galaxiidae; (*b*) relegated to *Paragalaxias* the South African Galaxiids *Cobitis zebratus* Castelnau, 1861 and *C. punctifer* Castelnau, 1861 (treating the second as a synonym of the first); (*c*) synonymised *P. shannonensis* with *Galaxias dissimilis,* thus making the latter the genotype. In catalogues of Australian fishes the synonymisation of Regan's and Scott's species has been rejected by Munro (1957:33, figs 228, 229), but accepted by Whitley (1964:35): the latter author, however has continued (1956 *a*:34) to regard the South African and Tasmanian fish as non-congeneric, listing *Cobitis zebratus* under *Agalaxis, C. punctifer* under *Galaxias.* Reasons are advanced below for regarding both of Stokell's propositions (*b*) (main clause) and (*c*) as invalid.

Possible zoogeographic implications of the posited occurrence in, and restriction to, the Tasmanian highlands and the South West Cape region of South Africa of an apparently highly specialised Galaxiid genus are clearly of considerable moment: maintaining his assumption of congenericity, Stokell (1953) has discussed the distributional problem thus presented. In a recent review of the Tasmanian fauna Guiler (1965), presumably accepting Stokell's taxonomic conclusions, states Tasmania has no endemic genus of freshwater fishes (the observation being correct of course if Regan's specimen had an extra-Tasmanian origin).

STATUS OF *PARAGALAXIAS* AND *AGALAXIS*

(i) *Location of dorsal fin.* Of the two specifications given in the entry in the diagnosis of *Paragalaxias* "the dorsal fin well forward, at about level of ventrals," the first may conveniently be spoken of as quantitative, the second as qualitative. By directing attention to, and casting new light on, the quantitative clause Stokell (1950) arrived at two species of *Paragalaxias*: *P. dissimilis* (Regan) (incorporating *P. shannonensis*), with dorsal inserted at 0.54-0.59 of standard length, *P. zebratus* (Castelnau) (incorporating *Cobitis punctifer*) at 0.55-0.63.

The qualitative aspect is wholly ignored in Stokell's paper. With dorsal originating at 1-2% of standard length behind pelvic origin (*P. shannonensis*) and at 9% in advance of pelvic origin (Regan's specimen) the specification of dorsal origin "at about level of ventrals" surely carries a significant connotation not reasonably applicable to any other known Galaxiids.

It is pointed out in Section II, below, that the similarity of an early dorsal insertion observable in *Paragalaxias* and *Agalaxis* is the outcome of different morphological trends, involving in the former a relative forward translocation of the dorsal unaccompanied by a like movement of the anal, in the latter a relative forward migration of both fins. The situation in *Agalaxis*, but not in *Paragalaxias*, is thus formally capable of being accounted for by a simple relative decrease in precaudal length; a development that the relative forward displacement also of the pelvic (Table II) suggests has indeed occurred.

(*ii*) *Reduction in number of vertebrae, pelvic rays, ova.* Reductions (very marked for vertebrae and ova) below the *Galaxias* norms for these features are adduced in Stokell's 1950 paper as further evidence of the congenericity of the Tasmanian species (plus *G. dissimilis*) and the South African fish. These three characters (at the same levels of magnitude) are shared with the other small-species genus *Brachygalaxias*: see Section II.

(iii) *Dorsal base relative to anal base.* The Central Tasmanian fish and *G. dissimilis* are unique in the Galaxiidae in having dorsal base regularly and significantly longer than anal base. In the type material of *P. shannonensis* the ratio of dorsal base to anal base is 1.6-2.1, mean 1.93 $\pm$ 0.08, in the holotype of *G. dissimilis* 2.4; whereas in our 20 examples of *Agalaxis* it is 0.7-1.0, mean 0.89 $\pm$ 0.03.

(*iv*). *Number of dorsal and anal rays.* The South African fish follow the usual Galaxiid pattern in having dorsal rays fewer than, or as many as, anal rays. Thus Barnard (1943) records "D. 3-4, 8-9; A. 3-4, 8-10 (total in both cases 11-13)": in our 20 specimens dorsal rays number 10(4), 11(9), 12(7), mean 11.15, anal 10(2), 11(7), 12(9), 14(2), mean 11.65 (no individual with dorsal count exceeding anal). Fish here referred to *Paragalaxias* are unique in having dorsal rays consistently and noticeably more numerous than anal rays; the types of *P. shannonensis* having dorsal 14(4), 15(3), mean 14.3, anal 9(6), 11(1), mean 9.3, and Regan's type 13 dorsal (Stokell (1950) counts 14) 9 anal.

(*v*). *Cephalic pores.* The cephalic pores of the Galaxiidae have not been systematically investigated; but available evidence suggests certain patterns (rather similar) are characteristic of, or strongly modal in, the genera. The South African fish differ from the Tasmanian thus: 2 pores beneath lower lip in latter (presence noted by Stokell (1950:2)) are missing in the former (absence correctly indicated in figure by Barnard (1943: fig. 25)); pore internal to posterior nostril is confluent with nostril only in *Paragalaxias* (both species); an inconstant (when present usually small) pore lying in *Agalaxis* below and in advance of a single constant suborbital pore has not been detected in Tasmanian *Paragalaxias;* in *Paragalaxias* the upper two pores bordering the preoperculum occasionally from a single slot. See also Section II.

STATUS OF *P. SHANNONENSIS* AND *P. DISSIMILIS*

As noted above, the two species have been synonymised by Stokell (Regan's species thus becoming the genotype); but they are clearly distinct. *P. dissimilis* is the sole known Galaxiid with dorsal originating in advance of pelvic (in the unique holotype, of standard length 65 mm., dorsal precedes pelvic by 6 mm., equal to length of snout, or anal base). In *P. shannonensis* dorsal begins 1-2% of standard length behind pelvic. This feature alone clearly calls for specific distinction. Other differences, of varying significance, found in *P. dissimilis* include: pelvic insertion relatively more caudad (at 0.66 of standard length; *cf* Stokell's diagnostic 0.52-0.54: hence fish nominated by Stokell as holotype cannot, in respect of this feature, enter the species (or genus) as defined by him), anal rather more caudad; dorsal base longer relative to anal base, head larger, snout longer, eye smaller, mouth larger, caudal peduncle shorter and deeper. Some of these features are known to be

correlated with overall size, and Regan's specimen is larger than the largest recorded Tasmanian fish: however, extrapolations of significant regression equations for the first two items listed above yield predicted values well below those found in *P. dissimilis.*

The genus *Paragalaxias* thus includes no South African representatives. It comprises two species, *P. shannonensis* Scott, 1935, the genotype, recorded only from Tasmania, and *P. dissimilis* (Regan, 1906), of unknown origin. *Agalaxis* is considered further under a separate heading.

GENUS VII. *NESOGALAXIAS* Whitley, 1935.

This name was proposed, without diagnosis, for *Galaxias neo-caledonicus* Weber & De Beaufort, 1913, from New Caledonia (trivial name now usually rendered without hyphen). With only the figure by Whitley (1935, pl. iii, fig. 4) before him, Stokell (1945:130) called attention to the large head (about 3 in standard length) and suggested the possibility of deformity. No feature in the original description would seem to preclude attribution to *Galaxias.* However, no useful opinion on the status of the species can be expressed without a study of specimens. If further examination establishes generic distinctness, *Nesogalaxias* is available when formally completed.

GENUS VIII. *LYRAGALAXIAS* Whitley, 1935

This name, appearing only in the legend to the figure (pl. iii, fig. 5), was proposed in the same paper as the last genus for *Galaxias o'connori* Ogilby, 1912 (trivial name generally rendered *oconnori*), from Lyra, South Queensland. The species has since been reported (Whitley, 1955:154, fig. 2) also from New South Wales. The status of *G. oconnori* has been discussed by Stokell (1945:130). The author of the genus has since abandoned it (1955:154):(the species does not appear in his 1964 list, having been synonymised with *Galaxias kayi* Ramsay & Ogilby, 1886 by Whitley, 1957: 57, fig. 2).

GENUS IX. *QUERIGALAXIAS* Whitley, 1935

Querigalaxias was proposed, in the legend to the plate (pl. iii, fig. 9), in the same paper as *Nesogalaxias* and *Lyragalaxias,* for *Galaxias dissimilis* Regan, 1906. A supposed difference in dentition between Regan's species and *Paragalaxias shannonensis* led Scott (1936:111) to observe *Querigalaxias* would be available for the former on formal completion. However, with Barnard's demonstration, noted above, that the extra row of teeth reported in *Paragalaxias* is merely a replacer row, occurring in all Galaxiids in which it has been looked for, it became evident Regan's fish is to be referred, as indicated above, to that genus.

GENUS X. *SAXILAGA* Scott, 1936

Since the establishment of *Saxilaga* (with subgenera *Saxilaga,* Tasmania; *Lixagasa,* New Zealand) further investigations have shown that certain diagnostic features originally described as absolute probably are not so. Descriptions of all three species specify the palate as edentulous. However, in specimens ascribed, with some dubiety, to *S. burrowsius* (Phillipps, 1926) (of which no additional strictly topotypical material appears to be available) Stokell has found entopterygoidal teeth "usually present, but weak and inconstant, 0-3 on each bone." Again, the "3 to 4 rows of large teeth on the tongue" of the original account of that species was employed ("lingual teeth in more than two series") in the diagnosis of *Lixagasa,* of which subgenus it was made the type. However, Stokell reported that in his material just mentioned the lingual teeth "may be disposed in two rows, four rows or any intermediate arrangement"— the minimum being the number usual in *Galaxias.* A pelvic ray count of 5 reported by Phillipps was made a criterion of the subgenus: but in 10 individuals of his material Stokell (1945:125) found 5 with 5 rays, 2 with 5-6, 2 with 6-6*, 1 with 6*6* (the asterisk indicating inclusion of one rudimentary ray). If *Saxilaga* is to be maintained, therefore, modal and not absolute criteria are to be accepted for these three features (a course in line with the contemporary population concept, which replaces the older typological concept, of a species).

The three species at present ascribed to *Saxilaga*—Stokell, who earlier (1945:134) listed the genus as "not recognised", has mooted the possibility (1959:268) that the South American *Galaxias globiceps* Eigenmann, 1928, may belong here—exhibit these common features: elongate body; small eye; small head; reduced number of pelvic rays (modally 5 or 6); paired fins short; vertical fins low, squarish, their rays compressed, with or without reduction in branching (this last clause applicable also to pectoral); anal continuous or subcontinuous with caudal ridge, which is well developed, high; caudal rounded or subtruncate; fish heavily pigmented. Taken singly, most, if not all, of these features can be matched in various species of *Galaxias*: taken collectively, they appear to constitute a significant constellation, and a competent systematist handling adult material would probably relegate it, without undue difficulty, either to *Galaxias* or to *Saxilaga*.

On our present knowledge, the genus is thus probably worthy of retention. The abolition of an absolute distinction in dentition from *Galaxias* might suggest *Saxilaga* would better be regarded as a subgenus of *Galaxias*. On the other hand, the occurrence, within *Saxilaga* as constituted, of two groups, at present accorded subgeneric status, that differ at least modally in pelvic ray number and in lingual dentition, as well as in distribution, would point towards the present treatment as more convenient. The genus is rejected by Stokell, but accepted by Munro and Whitley: the last-named treats *Lixagasa* as a genus (1956 *a*). An erroneous ascription of *Saxilaga* (*Lixagasa*) *burrowsius* to *Paragalaxias* has been noticed in the discussion on that genus.

Tasmanian material published on is confined to the holotype (now lost) of *S.* (*S.*) *cleaveri* (Scott), 1934, and the holotype and one paratype of *S.* (*S.*) *anguilliformis* Scott, 1936. Additional *Saxilaga* material, however, has now become available; detailed examination of this should throw fresh light on the problems of the genus. Mr. B. C. Mollison, the collector of nearly all the specimens, informs me he has observed ecological and behaviouristic differences between these fish and typical *Galaxias*.

A statement in the description of *S.* (*S.*) *anguilliformis* on the number of pores and myomeres has been incorrectly interpreted by Barnard (1943:231) as a count of 73 myomeres. Examination of the holotype shows that the myomeres (which are unusually difficult to count) number about 63.

GENUS XI. *LEPIDOGALAXIAS* Mees, 1961

A satisfactory determination of the status of the remarkable scaled *Lepidogalaxias salamandroides* Mees, 1961 from the south-west of Western Australia calls for further investigation, in particular a full osteological examination. The present provisional remarks are based on the published data—the describer's account and illustrations and a sketch provided by Whitley (1960:27)—and an examination of the external features of a single topotypical individual. The writer's present inclination is to regard the fish as lying outside the Galaxiidae: though if it is to be indeed excluded from this family, he can at present suggest no established group to which it could be referred; a new family is perhaps called for.

Points suggestive (at varying levels of significance) of non-Galaxiid affinities include the following [the normal Galaxiid specification being noted, where it seems expedient, in square brackets]: (*a*) presence of scales; (*b*) relatively high implantation of pelvic, such that when fins are casually adpressed they lie along flank [along ventral surface]; (*c*) small number (4) of pelvic rays [usually 5-7] and their simple character; (*d*) disposition of nostrils (this differs in the specimen from the figured condition (Mees, 1961: fig. 1 *a*), the anterior nostril lying in our example near level of middle of eye, the posterior slightly above level of pupil, bringing the general arrangement closer to, though not identical with, the normal Galaxiid pattern than that shown in the illustration); (*e*) anterior nostril a simple opening [tubular]; (*f*) position and general form of mouth, in particular, first, the subhorizontal gape (backwards and slightly upwards in Mees' figure, backwards and slightly downwards in Whitley's figure and specimen) [more oblique], and, secondly, the structure and relations of the upper lip, the superior margin of which is

seen in both figures to continue forward right to profile of snout (fish in lateral view) and is found in the specimen to be continuous across tip of snout, in traversing which the shallow sulcus delimiting it curves boldly caudad, making median depth of lip much greater than lateral depth, and lending the whole mouth, seen from in front, quite a turtle-like appearance [hind border of lip ceases on each side just internad of anterior nostril]; (*g*) reported presence of vomerine teeth; (*h*) reported absence of lingual teeth; (*i*) absence, as reported, and as found in specimen, of cephalic pores [one of the original specifications (Cuvier, 1816) of "Les Galaxies" is "Les côtés de leur tête offrent des pores"; pores also regularly occur on the top of the head]; (*j*) presence of accessory structures near vent—in one type specimen (female) in the form of a "rodlike tubular organ" (ovipositor?) protruding from vent (fig. 1 *a;* also indicated in Whitley's figure), and in several other type specimens, at least one of which is a male, in the form of two pairs of "dermal flaps" partly encasing anal fin (figs. 1 *b*, 1 *c*); (*k*) relationships, on ventral surface, of the opercles, the borders of which, in advance of the branchiostegal membranes, converge in the specimen, more or less evenly, to meet, or virtually to meet, at a point [in Galaxiids examined the borders run forward widely separated by the tongue-like anterior portion of the isthmus (usually somewhat inflated, its median bulge below level of lower lip), which, in advancing, broadens somewhat, so that the inferior margins of the subopercula come at their anterior terminations, where they overlie the chin, to lie well apart, being separated modally by about one-third of width of head here]; (*l*) slight development of ridges along caudal peduncle].

Some of these features could well represent specialisations of a Galaxiid norm—and the writer would not necessarily exclude from this category item (*a*); both naked and scaled forms within a family occurring in a number of cases—and some entries may be based on imperfect observation or incorrect interpretation. However, it would seem difficult to harmonize, in particular, items (*e*)-(*k*) with our present concept of the Galaxiidae.

A colour transparency of a living *Lepidogalaxias* (conspecific?) kindly made available by Mr. B. Shipway, the discoverer of *Brachygalaxias* in Western Australia, presents some striking features. The fish is balancing, just above and subparallel with the substratum, on the pelvic, the detectable portion of which consists of short, stoutish, seemingly rigid, widely spaced rays or ray segments; dorsal is fanned out, width exceeding twice base, with 4 of the 6 rays directed forwards, proximal part of first at an angle of about 45° to dorsal profile of fish; no longitudinal colour band, but about a dozen dark brown saddles and some other dark brown markings on a lighter brown background; some whitish spots on anterior part of flank; conspicuous dark spot, partly encircled by lighter, on operculum.

GENUS XII. *AGALAXIS* Scott, 1936

The affinities of this genus—established as a subgenus of *Galaxias* solely on the ground of its 6-rayed pelvic and its distribution; formally "not recognised" by Stokell (1945); later incorporated by the same writer (1950) in *Paragalaxias* —have been discused above under *Paragalaxias*. In 1943 Barnard observed (p. 231), "If the anatomy of the South African species had been better known, it is probable that Scott would have suggested full generic rank for *Agalaxis*." Generic rank is here proposed for it, a formal rediagnosis being given below.

Diagnosis: No scales. Teeth in jaws and on entopterygoids uniserial (with decumbent inner* row), conical; lingual teeth biserial with two outer decumbent rows).
Vertebrae 38-41. Anal base longer than, or equal to, dorsal base; the fins with an equal, or subequal, number of rays (ii-iv, 8-10, total 10-14). Dorsal largely over anal, originating at about (0.55) 0.59-0.67 of standard length. Pelvic rays modally 6. Branched caudal rays modally 12. Pores on each lateral

*Outer, reported by Barnard (1943:232) is a slip; corrected, at Barnard's request, in Stokell (1950:1).

half of head 14, sometimes 15; disposed as figured by Barnard (1943, fig. 25); pore near posterior nasal opening not confluent with it; no inframandibular pores. Branchiostegals 6-7. Gillrakers on anterior arch about 2-3 + 9-10. Size small (greatest recorded total length 75 mm.); sexually mature at about 40 mm.

Orthotype: *Cobitis zebratus* Castelnau, 1861 = *Agalaxis zebratus* (Castelnau, 1861).

Scope: Comprises *Cobitis zebratus* Castelnau, 1861, *C. punctifer* Castelnau, 1861, *Galaxias capensis* Steindachner, 1894, *G. dubius* Gilchrist & Thompson, 1917—of which the third and fourth are almost certainly synonyms of the second, which is treated by some authors, *e.g.*, Stokell (1950) as synonymous with the first, but regarded by others, *e.g.*, Regan (1906), Boulenger (1915), Barnard (1947), Jubb (1963, 1964) as distinct.

Distribution: As far as is known, endemic to South Africa, where it is the sole Galaxiid genus.

Affinities: *Agalaxis* differs trenchantly from *Galaxias, Neochanna* and *Saxilaga* in its small number of vertebrae. From genera with a comparable vertebral complement it is distinguished thus: from *Lepidogalaxias* by absence of scales, and of accessory organs near vent, different dentition, tubular anterior nostril; from *Brachygalaxias* by having dorsal origin modally cephalad, instead of regularly caudad, of anal origin, absence of pelvic-anal keel; from *Paragalaxias* by having dorsal base largely over anal base (contrast chiefly over pelvic-anal interval), dorsal (length of base, number of rays) less than or equal to (contrast notably exceeding) anal, absence of inframandibular pores (2 present), posterior nostril and adjoining pore separate (confluent).

PART II. — CONVERGENCE AND DIVERGENCE IN CERTAIN GENERA

Of the three chief features employed, in the course of an early attempt (Scott, 1936:7) at sorting out generic (and subgeneric) relations to distinguish a proposed subfamily Paragalaxiinae (comprising *Paragalaxias shannonensis* and *Galaxias dissimilis*) from typical Galaxiinae—dorsal inserted about over pelvic, teeth in jaws biserial or uniserial, vertebrae fewer than 50—the first alone remains valid, the second being based, as noted above, on a misapprehension, the third being rendered nugatory by subsequent publication of low vertebral totals for *Brachygalaxias* (Scott, 1942; Stokell, 1954) and for *Agalaxis* (Barnard, 1943). Thus though *Paragalaxias* still holds a special position as regards the location (and great development) of the dorsal fin, it is less isolated than was formerly thought. Indeed, on present knowledge a more natural division of the family, if one is to be made, would appear to involve the association, on one hand, of forms with more than 50 vertebrae (*Galaxias, Saxilaga, Neochanna*) and, on the other hand, of forms with fewer than 50 vertebrae (*Brachygalaxias, Paragalaxias, Agalaxis*): *Lepidogalaxias* (with—unpublished datum—about 40 myomeres), if included in Galaxiidae, stands apart on other grounds.

The genera, other than *Lepidogalaxias*, with few vertebrae appear to present a case of convergent evolution following on radiation. *Paragalaxias* is recorded only from Tasmania (locality of *P. dissimilis* unknown), *Agalaxis* is endemic to South Africa, *Brachygalaxias* occurs in South America and Australia (Victoria, Western Australia, Tasmania). Among recent forms *Galaxias* presumably remains closest to the primitive stock; the only known fossil Galaxiid, *G.* + *kaikorai* Whitley, 1956, from deposits near Dunedin regarded as late Pliocene exhibiting (Stokell, 1945:135, pl. 11, 12) no more than specific differences from existing species. (Berg, 1940 states the Galaxiidae show some relation to the Eocene Thaumaturidae). Divergences from a *Galaxias* norm presented by all three genera are set out in Table 1.

TABLE 1

CONVERGENT EVOLUTION IN THE GENERA *BRACHYGALAXIAS, PARAGALAXIAS, AGALAXIS*: FEATURES IN WHICH THEY DEPART FROM *GALAXIAS*

1. Reduction in size.
2. Reduction in number of vertebrae.
3. Reduction in number of ova.
4. Migration along anteroposterior axis of one or more of dorsal, anal, pelvic fins.
5. Reduction in number of pelvic rays.
6. Reduction, usually accompanied by instability, in number of branched caudal rays.
7. Reduction, with some instability, in cephalic pores.
8. (Typically) large eye.

Some comments on these features: 1, standard length usually less than 75 mm.; 2, 34-44; *Galaxias* 51-63:3, highest reported 88; one count (unpublished) in *G. attenuatus* 11, 856:4, these three genera are convergent in respect of the occurrence of such migration; they are divergent (Table 2) in respect of its character: 5, modally 5 or 6; *Galaxias* modally 7 (a mode of 6 reported for type material of *G. divergens* Stokell, 1959) :6, *Brachygalaxias* 5-14 (see under that genus), *Paragalaxias* 11-14, commonly 14, *Agalaxis* 12; *Galaxias* 14:7, series in *Galaxias* typically includes (*a*) one suborbital, (*b*) 2 inframandibular, (*c*) a pore between (*a*) and hind pore of (*c*); reduction usually occurs in *Paragalaxias* by loss of (*c*), in *Agalaxis* and *Brachygalaxias* by loss of both elements of (*b*), with (*c*) inconstant: 8, this feature is not constant.

It will be observed that most of the features in Table 1 represent reductions on the condition found in *Galaxias*. At least some of them could well be directly consequent upon entry 1 or entry 2 (whichever may be considered formally prior). Thus, for example, with egg not readily efficiently reducible, in view of physiological and ecological limiting factors, beyond a certain minimum size, decrease in coelom-volume would entail decrease in egg-number; again, diminution in absolute size might, in fishes as small as these, tend mechanically to lead to reduction in caudal ray number.

A concept of *Saxilaga* as an annectant form between *Galaxias* and *Neochanna* suggested by the writer (1936:106), Phillipps (1940, 39), and others has been criticized by Stokell (1945:132). Morphologically *Saxilaga* is demonstrably intermediate between the two other genera: whether or no *Galaxias—Saxilaga—Neochanna* is a lineal genetic series is indeed another question.

In the comments on Table 1 attention is called to the fact that dorsal, anal and pelvic migration takes different forms in the three genera there considered; translocation occurs also in the other genera. Such "migration" can of course result from alteration in proportional length of one or more body regions (head, trunk, tail), as well as from actual local shifting about a conventionally fixed morphological landmark, such as the vent. Table 2 summarizes generic trends in regard to dorsal, anal and pelvic location and records also variation in length of base of vertical fins.

TABLE 2

DIVERGENT EVOLUTION IN GALAXIID GENERA: LOCATION AND SIZE OF FINS

With lengths to dorsal, anal, pelvic fins, and with lengths of dorsal, anal bases, all expressed as fractions of standard length, as found in *Galaxias* taken as norms, the table shows these features for all genera: 0, +, — indicate, for fin origin, null, caudad, cephalad displacement, respectively, and, for length of base, equality, increase, decrease, respectively; cases in which species means lie wholly outside range of species means of *Galaxias* are marked with an asterisk.

Genus	Length to Origin			Length of Base	
	Dorsal	Anal	Pelvic	Dorsal	Anal
Galaxias	0	0	0	0	0
Brachygalaxias	0	—	—	—	0
Saxilaga	0	+	0	+	0
Paragalaxias	—	0	+	+	—
Agalaxis	—*	—	—	+*	0
Neochanna	+	—	. . .	+	+*
Lepidogalaxias	—	—	—*	—*	—

With *Lepidogalaxias* excluded from the discussion, except where expressly mentioned, it is seen that, in the case of the dorsal-anal complex, six of the nine formal possibilities have been reified, both dorsal and anal having moved twice, anal alone twice, dorsal alone once, neither fin once (by definition). (*Lepidogalaxias* presents the same pattern as *Agalaxis;* though the translation has been, for each fin, only about two-thirds as much). The forward movement in anal in *Brachygalaxias* is of the same order of magnitude as its forward movement in *Agalaxis* (*i.e., Brachygalaxias* is, in respect of vertical fin location, formally *Agalaxis* devoid of dorsal migration) and its backward movement in *Saxilaga.* For the complex dorsal-anal-pelvic there are of course again as many combinations as there are genera (*Lepidogalaxias* providing a seventh). *Paragalaxias* alone shows caudad movement of the pelvic, though the fin has moved forward in two genera (and *Lepidogalaxias*). The triple negative entry for *Agalaxis* has already been commented on.

Table 2 exhibits also trends in the relative lengths of the bases of the vertical fins, with *Galaxias* as standard. Here only five combinations (with *Lepidogalaxias,* six) are represented, the same pattern occurring in *Saxilaga* and *Agalaxis.* The anal is seen to have proved more stable in size than the dorsal.

In this table, based on the best data available, generic means only are taken account of: except for the four variates mentioned in the next sentence, together with *Neochanna* anal, species means overlap (though in several instances only slightly) the wide range of species means of *Galaxias.* Extreme variations of generic means on *Galaxias* mean are much less for lengths to fin

origins (up to one-fifth greater for dorsal of *Paragalaxias,* and about the same less for pelvic of *Lepidogalaxias*) than for lengths of fin bases (*Paragalaxias* dorsal more than double, *Lepidogalaxias* dorsal little more than one-third of, *Galaxias* values).

The complete run of negative values for *Lepidogalaxias* is of interest as being at least compatible with the suggestion here put forward that this genus may lie outside the Galaxiidae. Differences shown in the table between, on the one hand, *Galaxias* and *Saxilaga,* and on the other hand *Paragalaxias* and *Agalaxis* in part restate, in part provide additional grounds for accepting, the distinctness of the members of each of these pairs of genera recognised earlier in the paper.

Investigations now in progress should throw light on some of the problems here left unresolved.

REFERENCES

Barnard, K. H., 1943.—Revision of the indigenous freshwater fishes of the S.W. Cape region. *An. S. Afr. Mus.,* XXXVI, ii: 101-262, 33 text-figs.

————, 1947.—*A pictorial guide to the South African fishes marine and freshwater.* Capetown.

Berg, L. S., 1940.—The classification of fishes both recent and fossil. *Trav. Inst. zool. Acad. Sci. U.R.S.S.,* 5:87-517, 90 figs. (in Russian: not seen). Edition in Russian and English, 1947, Ann Arbor, Michigan.

————, 1955.—*Id.,* 2nd ed. *Ibid,* 20:1-286, 263 figs. (in Russian: not seen).

Boulenger, G. A., 1915.—Catalogue of the freshwater fishes of Africa in the British Museum (Natural History), III. London.

Castelnau, F. L., 1861.—*Mémoire sur les poissons de l'Afrique Australe.* Paris.

Chapman, W. M., 1944.—On the osteology and relationships of the South American fish, Aplochiton zebra. *J. Morph.,* 75:149-165, figs. 1-10.

Cuvier, G., 1816.—*Le règne animal distribué d'après son organisation,* ed 1, vol. 2, Paris.

Eigenmann, C. H., 1928.—The freshwater fishes of Chile. *Mem. nat. Acad. Sci. Wash.,* XXII, 1 (second memoir): 1-81, pls. I-XVI.

Gosline, W. A., 1960.—Contributions towards a classification of modern isospondylous fishes. *Bull. Br. Mus. (nat. Hist.)* Zool., 6, 6:327-365, figs 1-15, diagrs. 1-3.

Guiler, E. R., 1965.—Animals: 36-37, fig. 30, in *Atlas of Tasmania* (J. L. Davies editor). Hobart.

Günther, A., 1866.—*Catalogue of the fishes in the collection of the British Museum,* VI. London.

————, 1867.—On a new form of mudfish from New Zealand. *Ann. Mag. nat. Hist.* (3), XX:305-309, pl. VII.

Jenyns, L., 1842.—*The zoology of the voyage of H.M.S. Beagle during 1832-36,* IV. London.

Jubb, R. A., 1963.—A revised list of the freshwater fishes of southern Africa. *Ann. Cape Provincial Mus.,* III: 5-39.

————, 1964.—Freshwater fishes and drainage basins in southern Africa. *S. Afr. J. Sci.,* 60, 1:17-21.

Lord, C. E. & Scott, H. H., 1924.—*A synopsis of the vertebrate animals of Tasmania.* Hobart.

McCulloch, A. R., 1921.—List of the fishes and fish-like animals of New South Wales. *Aust. Zool.,* II, 2:24-68, pls. IV-XXIV.

————, 1929.—A checklist of the fishes recorded from Australia. *Mem. Aust. Mus.,* V, (IV, index, 1930). Sydney.

Mack, G., 1936.—Victorian species of the genus *Galaxias* with descriptions of new species. *Mem. nat. Mus. Melb.*, 9: 98-101, figs. 1-2.

Mees, G. F., 1961.—Description of a new fish of the family Galaxiidae from Western Australia. *J. roy. Soc. W. Aust.*, 44, 2: 33-38, fig. 1, pls. I-II.

Munro, I. S. R., 1957.—*Handbook of Australian Fishes*—currently (1956+) appearing serially in *Australian Fisheries Newsletter* (formerly *Fisheries Newsletter*); *Galaxiidae*: 32-35 (vol. 16, 1-2). Canberra.

Ogilby, J. D., 1899.—Contribution to Australian ichthyology. *Proc. Linn. Soc. N.S.W.*, XXIV, 1: 154-186

Phillipps, W. J., 1926.—New or rare fishes of New Zealand. *Trans. Proc. N.Z. Inst.*, 56: 529-537, pls. 87-92.

————, 1927.—A bibliography of New Zealand fishes, *N.Z. Mar. Dept. Fish. Bull.* 1: 1-68.

————, 1940.—*The fishes of New Zealand,* vol. 1. New Plymouth.

Regan, C. T., 1906.—A revision of the fishes of the family Galaxiidae. *Proc. zool. Soc. Lond.* (1905), II: 363-384, pl. X-XIII.

————, 1913.—The antarctic fishes of the Scottish national Antarctic expedition. *Trans. roy. Soc. Edinb.*, 49, 2:229-292, 11 pls., 6 text-figs.

Scott, E. O. G., 1934.—Observations on some Tasmanian fishes, with descriptions of new species. *Pap. Proc. roy. Soc. Tasm.* (1933): 31-53, pls. 6-7, text-figs. 1-2.

————, 1935.—On a new genus of fishes of the family Galaxiidae. *Pap. Proc. roy. Soc. Tasm.* (1934):41-46, pl. III, text figs. 1-2.

————, 1936.—Observations on fishes of the family Galaxiidae: Part 1. *Pap. Proc. roy. Soc. Tasm.* (1935): 85-112, text-figs. 1-4.

————, 1942.—Description of Tasmanian mud trout, *Galaxias (Galaxias) upcheri sp. nov.*: with a note on the genus *Brachygalaxias* Eigenmann, 1928. *Rec. Queen Vict. Mus.*, I, 1:51-57, pl. X.

————, 1965.—Observations on Galaxiid systematics. Paper (unpublished) presented at 38th Congress of Aust. and N.Z. Assoc. for Adv. Sci., Hobart.

Scott, T. D., 1962.—*The marine and freshwater fishes of South Australia.* Adelaide.

Shipway, B., 1953.—Additional records of fishes occurring in the freshwaters of Western Australia. *West Aust. Nat.*, 3, 8:173-177, 1 fig.

Stokell, G., 1940.—A new species of *Galaxias. Trans. roy. Soc. N.Z.*, 69:422-424, pl. 57.

————, 1945.—The systematic arrangement of the New Zealand Galaxiidae: Part I, Generic and sub-generic classification. *Trans. roy. soc. N.Z.* 75, 2:124-135, pls. 8-12.

————, 1949.—The systematic arrangement of the New Zealand Galaxiidae: Part II, specific classification. *Trans. roy. soc. N.Z.*, 77, 4:472-496, pls. 52-57, text-fig. 1.

————, 1950.—A revision of the genus *Paragalaxias. Rec. Queen Vict. Mus.*, III, 1:1-3, pl. 1.

————, 1953.—The distribution of the family Galaxiidae. *Proc. 7th Pac. Sci. Congr.*, 4:48-52.

————, 1954.—Contributions to galaxiid taxonomy. *Trans. roy. Soc. N.Z.*, 82, 2:411-418, pl. 22.

————, 1955.—*Freshwater Fishes of New Zealand.* Christchurch.

————, 1959.—Notes on galaxiids and eleotrids with descriptions of new species. *Trans. roy. Soc. N.Z.* 87, 3-4:265-269, pls. 21-22.

Tillyard, R. J., 1933.—Report on the problem of trout-food on the lakes and rivers of Tasmania; Appendix A of salmon and freshwater fisheries commissioners' report for year ending 30th June, 1933. *Tasm. parl. Pap.*, no. 11.

Waite, E. R., 1921.—Illustrated catalogue of the fishes of South Australia. *Rec. S. Aust. Mus.*, II, 1:1-208, pl. i, text-figs. 1-293.

Weber, M. & De Beaufort L. F., 1913.—Uber neue fische von Neu-Kaledonien. *Zool. Anz.* 42: 172-174.

Whitley, G. P., 1933.—Studies in ichthyology; No. 7. *Rec. Aust. Mus.* XIX, 1:60-112, pls. 11-15, figs. 1-4.

————, 1935.—Whitebait. *Vict. Nat.,* LII, 3 (169):41-51, pl. III, text figs. 1-2.

————, 1955a.—Taxonomic notes on fishes. *Proc. roy. zool. Soc. N.S.W.* (1953-4): 44-57, text-figs. 1-8.

————, 1955b.—Opus ccc. *Aust. Zool.,* 12, 2:154-159, text-figs. 1-7.

————, 1956a.—The story of *Galaxias. Aust. Mus. Mag.,* XII, i:30-34, 3 figs.

————, 1956b.—List of the native freshwater fishes of Australia. *Proc. roy. zool. Soc. N.S.W.* (1954-55): 39-47, figs. 1-16.

————, 1957a.—Ichthyological illustrations. *Proc. roy. zool. Soc. N.S.W.* (1955-56): 56-71, text-figs. 1-12.

————, 1957b.—The Freshwater Fishes of Australia. 7, 8. *Australasian AquaLife* 2(4):7-10, 3 figs. and 2(5):6-8, 7 figs.

————, 1960. *Native Freshwater Fishes of Australia,* Brisbane. And revised ed., 1964.

————, 1964. Presidential address: A survey of Australian ichthyology. *Proc. Linn. Soc. N.S.W.,* LXXXIX, 1:11-127.

A REVIEW OF THE AUSTRALIAN MAJID SPIDER CRABS (CRUSTACEA, BRACHYURA)

By D. J. G. Griffin

(Zoology Department, University of Tasmania, Hobart)

(Plates XV-XVII & Text-figures 1-3)

SUMMARY

An historical account is given of taxonomic studies of spider or masking crabs in Australia and overseas. The basis of the review is a key to all but two of the species known to occur in Australia. The key includes information on synonymies, geographic and bathymetric distribution and references to descriptions and illustrations of the species. Characters which are important in the classification are briefly reviewed. Zoogeographical relationships of the fauna are discussed.

The family Majidae is currently divided into seven subfamilies mainly on the basis of orbital configuration, form of the rostrum, abdomen and first pleopod of the male. All but one of the subfamilies are represented in the Australian fauna which is considered to comprise 95 species in 45 genera. This is about twice the number of species and genera listed by Haswell (1882c) in his "Catalogue." About one-third of the species have been recorded from Australia on only a single occasion. Numerous genera and species are in need of detailed reinvestigation.

The fauna is rather clearly partitioned into a tropical group with widespread Indo-West Pacific relationships and a temperate group related to tropical Australia and/or the Indo-West Pacific rather than to temperate regions outside Australia. There are no clear boundaries between these two faunas but rather quite broad transition areas. Thirty-seven species and five genera, most of which are temperate, are restricted to Australia.

1. INTRODUCTION

One of the most characteristic features of spider crabs of the family Majidae is the presence on the carapace and legs of special curled or "hooked" hairs which aid in the attachment of various kinds of epifauna and flora, especially seaweeds (for example see McNeill 1923). These organisms are placed in position by the crab with the aid of the chelipeds which are able to reach up on to the dorsal surface of the carapace. For this reason majid crabs are sometimes called "masking crabs" or "seaweed crabs." Of special interest in these crabs are the orbits which may be expanded in various ways and surrounded by a seemingly complex array of spines. The legs are often long and slender and the carapace usually triangular or pyriform. Spider crabs range in size from a few millimetres to more than a metre in carapace length and are found in almost all seas and oceans. They form a relatively important part of the benthos and may be locally very abundant on the shelf although some species extend considerable distances down the continental slope to depths as great as 1000 fathoms.

Substantial revisions of the family Majidae have been undertaken on a world-wide scale by Dana (1851), Miers (1879c), Alcock (1895) and Balss (1929). Sakai (1938), Stephensen (1945) and Garth (1958) have adapted Balss's scheme to the faunas of Japan, the Iranian Gulf and America respectively. In the course of these revisions the Majidae have been arranged in several very different fashions (see historical reviews by Miers 1879c, and Garth 1958). Early workers such as Dana and Miers grouped the species in several families and a large number of subfamilies—Dana's arrangement comprised five families and no less than 27 subfamilies. Alcock's was the first of these major revisions to contain the species in a single family. This was divided into four sub-families and seven "alliances." Whereas revisors before Balss had proceeded by rearrangement of previous schemes, Alcock's groups of genera were left almost untouched by Balss, his alliances in some cases being elevated to subfamilial rank much as they were conceived. The number of subfamilies currently recognised stands at seven following the work of Garth.

Many morphological characters have been used in these different classifications and some have been shown to be unreliable guides to phylogenetic relationships (see Section III). Characters concerned with the form of the orbit still dominate the classification but Garth has found, in the Pacific American fauna, groups of genera showing vast agreements in the form of the male first pleopod. This appendage is now realised to be of great value in the taxonomy of nearly all families of crabs.

The first Australian spider crabs to be described were made known by the European naturalists Herbst, Latreille and H. Milne Edwards in the early nineteenth century. In the second half of that century the work of Dana, Stimpson, Miers and Haswell resulted in substantial additions to knowledge of the Australian spider crab fauna. Dana in 1852 dealt with the Crustacea of the U.S. Exploring Expedition of 1838-1842, Stimpson with the Crustacea of the North Pacific Exploring Expedition led by Ringgold and Rodgers (Stimpson 1857—full report not published until 1907). Haswell published six papers between 1879 and 1882 and in that year (Haswell 1882c) provided the first list of all species known from Australia. But Miers's important reports on the material collected by the "Alert" in 1881-2 (Miers 1884) and by the "Challenger" in 1873-76 (Miers 1886) outdated Haswell's list to some extent. So too did the reports of W. T. Calman (1900) and A. Ortmann (1894) on collections of Brachyura from Torres Strait.

Haswell's work at the Australian Museum was followed by that of Thomas Whitelegge whose report on the Crustacea collected off eastern Australia by the "Thetis" (Whitelegge 1900) may be particularly mentioned. W. H. Baker (1905, 1906) dealt with South Australian Brachyura and S. W. Fulton, F. E. Grant and Allan R. McCulloch all paid some attention to south-eastern Australian species in the first and second decades of the present century. In the 1920's, Herbert M. Hale (1924, 1927, 1929) reported on southern and western species. The numerous reports, from the 1890's to the 1920's, by Mary J. Rathbun of the Smithsonian Institution at the same time added several species to the Australian lists and extended the known ranges of many others; two reports (Rathbun 1914, 1924) dealt with collections from Western Australia. S. K. Montgomery's report on the Brachyura of the Percy Sladen Trust Expedition to the Abrolhos (Montgomery 1931) and Dr. Heinrich Balss's paper (1935) on the material collected by the Hamburg Museum's Expedition to south-western Australia in 1905 are the latest sources of information on western spider crabs. The contemporary and later work of Frank A. McNeill and Melbourne Ward dealt mainly with north-eastern species.

The present situation with regard to the Australian majid spider crab fauna is thus as follows. No revisionary treatment has ever been attempted and no comprehensive guide has appeared since the time of Haswell. Until recently only McCulloch (1908, 1913) had completed revisions at the generic level. Nearly all reports dealing with majids have merely added species or extended known geographic ranges. The most important recent references to Australian species are those primarily treating overseas faunas (e.g. Sakai 1938, 1965; Buitendijk 1939; Barnard 1950; and Forest & Guinot 1961). The number of known valid genera and species has doubled since the time of Haswell and collections have continued to accumulate at various museums, particularly the Australian Museum, Sydney, and the Western Australian Museum, Perth. Several areas of the Australian coastline remain uninvestigated, particularly that west of Torres Strait south to Broome and most of the Great Australian Bight. The Australian Museum possesses a fine catalogue of all described genera and species. Not the least important of the many problems which therefore remain unanswered is the question of whether the Australian genera can be grouped, on the basis of the male first pleopods (unknown in the vast majority of local species), in an arrangement which parallels that found by Garth.

The present paper attempts to bring together available information on the Australian Brachyura of the family Majidae. This information is presented in the form of a key to genera and species with distributional and other information included. The following discussions centre around this key. Current problems are pointed out but there is no intention here of giving a general revision. Adequate treatments of the morphology of members of this family are

given by Rathbun (1925), Garth (1958) and Griffin (in press, b). Terminology, unless otherwise indicated, follows that used by Rathbun and Garth and by Griffin in previous papers. Although most information used in the key is taken from the literature, a considerable amount of material comprising most of the species represented in Australia, has been examined at the Australian Museum over the past three years.

II. THE FAMILY

The Majidae belong, with the Hymenosomidae (flat-back crabs) and the Parthenopidae (caltrop crabs), to the superfamily Oxyrhyncha. All three families possess an anteriorly narrowed and produced carapace with prominently expanded branchial regions, large epistome, quadrate buccal cavity and longitudinally folded antennules. The characters which chiefly distinguish majid crabs from other families of the Brachyura are: (1) the possession of specially mobile chelipeds; (2) fusion of the well-developed second article of the antenna (usually called the basal antennal article) to the epistome and often also to the front; (3) the comparatively incomplete orbits; (4) articulation of the palp of the external maxillipeds at the anteromedial angle of the merus; and (5) the much greater length of the first pleopods of the male relative to the second pair. The family has usually been considered in the past to share with other Oxyrhyncha nine pairs of gills on each side but Hartnoll (1964) has recently shown that this number is sometimes reduced in the Majidae to seven or eight.

It should be mentioned that the term Maioidea used by Dana and Miers is partially synonymous with Oxyrhyncha (as now understood) and not with the term Majidae (until recently frequently spelt Maiidae). In Dana's and Miers's time the Maioidea included only the Majidae and the Parthenopidae; de Haan's (1839) addition of the Hymenosomidae did not gain general acceptance until after Rathbun (1925).

As to the evolution and relationships of the Oxyrhyncha, Glaessner (1960: 46) states, "The Oxyrhyncha, or spider crabs, are . . . unrepresented before the Tertiary except by unidentifiable fragments. The pointed rostrum . . . and the prominent mesogastral-cardiac ridge, together with the elongate cephalothorax, place this group much closer to the Oxystomata than to the Brachyrhyncha, but it is more advanced in the organisation of its mouthparts."

III. THE SUBFAMILIES

The subfamilial arrangement adopted here is that proposed by Garth (1958) which is a modification of the schemes of Alcock (1895) and Balss (1929). In the delimitation of subfamilies and in the arrangement of genera within them, particular attention has been paid to the structure of the orbit, i.e., the degree of expansion of the anterolateral part of the carapace above the origin of the eyestalk (the "supraorbital eave"), the presence or absence, and form of, a spine behind the eave (the "postorbital spine") and the degree of expansion of the basal antennal article. These are characters used before Alcock by Miers (1879c) and to some extent by Dana (1851). H. Milne Edwards (1834) considered the length of the ambulatory legs to be important and the classification proposed by de Haan (1839) was based on the shape of the merus of the third maxillipeds. Use of these latter characters was criticised by Miers. In 1861 Claus proposed a classification based on the form of the basal antennal article. Use of this character was criticised by Stimpson in 1871. Balss laid particular stress on a further feature associated with the structure of the orbit: the presence or absence of a spine (the "intercalated spine") between the eave and the postorbital lobe. However, later workers on the group (Sakai 1938 and Garth 1958) have considered that Balss laid too much stress on this feature (see below). The relative size of this spine is sometimes variable with either growth or geographical locality (Garth 1958; Griffin, unpublished). Balss also introduced three other characters: the number of free segments of the abdomen (basically seven but sometimes reduced by

coalescence or fusion involving segments four to six inclusive), the degree of development of the interantennular spine (the true rostrum of the zoea) and the degree of fusion of the (pseudo) rostral spines.

In the key presented here genera within each subfamily are arranged in a series which begins with forms with a double rostrum and seven free abdominal segments in both sexes and ends with those in which the rostral spines are partly or wholly fused and the number of free segments in the abdomen is reduced. In this respect the key resembles those provided by Garth (1958). Implicit in such a presentation is the concept that parallel evolution has proceeded independently within each subfamily. The genera at the beginning of the series are considered to be primitive and those at the end advanced. This is in accordance with the ideas of Balss who considered that a well developed interantennular spine and the presence of an intercalated spine were also primitive features.

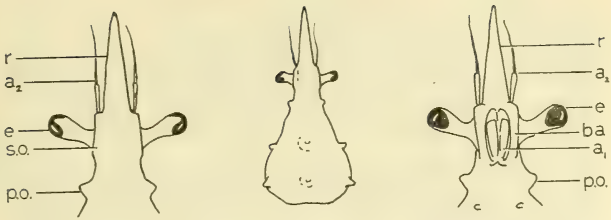
Some aspects of orbital structure require further clarification. The term "commencing orbit," used in respect of some of the Ophthalmiinae, Acanthonychinae and Pisinae, is intended to contrast with the unformed orbits of the Inachinae and some members of the Acanthonychinae on the one hand and with the complete or almost complete orbits of the Majinae and Mithracinae on the other. The commencing orbit is thus intermediate between two extremes. It involves partial enlargement of the supraorbital eave, most commonly by the development of a prominent spine either anteriorly or, less often, posteriorly; this spine scarely conceals the eyestalk from dorsal view.

In some inachines there is above the origin of the eyestalk a variously developed spine, considered by Balss to represent the intercalated spine. However, in the Inachinae, this spine is very seldom separated by distinct fissures from the surrounding parts of the orbit as it is in the Majinae and some Mithracinae. Further, in some inachine genera which appear to be natural groups, some species possess a spine above the eyestalk and some do not. It would seem better to call this spine merely a supraorbital spine and to disregard, at least for the present, any possible homology between it in the Inachinae and the intercalated spine of other majids.

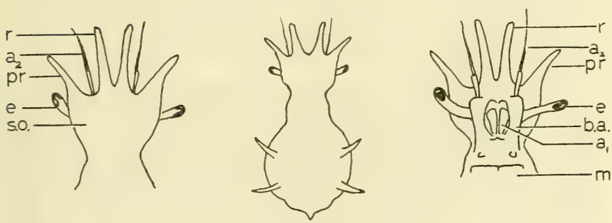
A similar difficulty exists in many of the Pisinae. In some the postorbital lobe is provided on the upper anterior edge close to the base with a prominent accessory lobe and in a few species this lobe is quite distinct from the postorbital lobe. In other pisines where the eave is virtually unexpanded a small denticle is present on the supraorbital margin. There this lobe or denticle appears to be the intercalated spine and is generally so treated here.

To sum up, emphasis on the intercalated spine led Balss to divide the Inachinae and the Pisinae each into two further subfamilies. In at least the Inachinae it is difficult to work out the homologies of a spine above the orbit in those species in which it is present and in the Pisinae Garth has found that such a division, in the Pacific American forms, is not supported by the male first pleopods. The term supraorbital spine is used, especially in the Inachinae, to denote a spine above the orbit where homologies are not clear. In other groups the term preorbital spine is restricted to mean an anterior outgrowth of the supraorbital eave and the term antorbital spine is used to denote a posterior outgrowth (see figure in Griffin in press, a).

Figure 1. Generalised morphology of the subfamilies Inachinae, Ophthalmiinae and Acanthonychinae. Front of the carapace from above at left and from below at right; whole carapace from above in the middle. Abbreviations: a_1, antennule; a_2, antenna; a.o., antorbital spine; b.a., basal antennal article; e, eye; i, intercalated spine; m, mouthfield; p.o., postorbital lobe; pr, preorbital spine; r, rostrum; s.o., supraorbital eave.



INACHINAE



OPHTHALMIINAE

ACANTHONYCHINAE

The characters of the six subfamilies represented in Australia are now given (the number of the couplet in the key at which genera of each subfamily begin is indicated in brackets after the name):

INACHINAE (4): Orbits undeveloped, or eave weakly expanded only; a supraorbital spine sometimes present. A postorbital spine sometimes present but affording no concealment to the cornea of the retracted eyestalk. Basal antennal article extremely slender and usually long. Eyestalk very long and visible almost to its base in both dorsal and ventral view. Carapace subtriangular or sometimes subpyriform or occasionally circular. Rostrum sometimes of a single spine, and frequently short. Ambulatory legs frequently extremely long and slender.

OPHTHALMIINAE (26): Orbits consisting of a well developed and laterally expanded eave or of a greatly elongated spine. Postorbital spine short. An intercalated spine never present. Basal antennal article moderately expanded only. Eyestalk very long, often concealed in dorsal view but always largely visible in ventral view. Carapace elongate and often truncate in front and provided with a medial expansion or spine posteriorly. Rostral spines distinct and usually short. Ambulatory legs seldom very long.

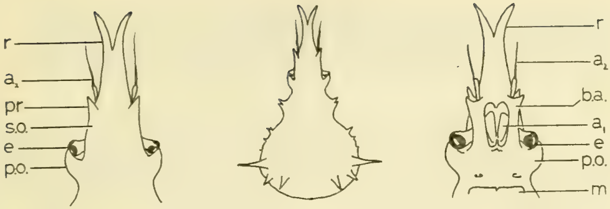
ACANTHONYCHINAE (29): Orbits undeveloped, eave rounded or forwardly produced as a preorbital spine. Postorbital spine, if present, simple and affording no concealment to eyestalk. Basal antennal article not very wide and characteristically truncate triangular. Eyestalks extremely short and often sunk in sides of rostrum. Carapace basically pyriform but characteristically twice expanded laterally at hepatic and branchial margins. Rostrum consisting either of two distinct spines or sometimes of a huge "beak." Ambulatory legs short or at most of moderate length.

PISINAE (36): Orbits with a weekly expanded eave either produced anteriorly as a preorbital spine or acute or sometimes posteriorly acute, or else weakly expanded midway along and almost confluent with the postorbital lobe. Intercalated spine present or absent, sometimes a small denticle or lobe close to the postorbital lobe. Postorbital lobe always well developed and cupped but not completely concealing the eyestalk from dorsal view. Basal antennal article slightly to broadly expanded and usually produced into a spine anterolaterally. Eyestalk typically short and bulbous with a large cornea. Carapace always pyriform although sometimes very wide. Rostrum frequently bifid for distal half only. Ambulatory legs often very long and slender.

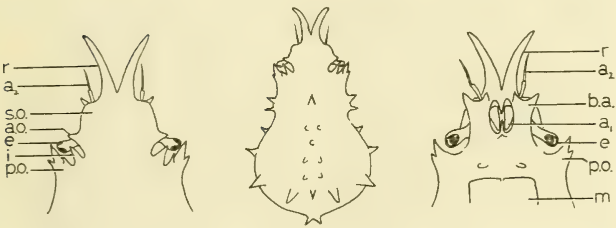
MAJINAE (62): Orbit well developed, comprising above a laterally expanded eave which is always acute posteriorly and sometimes produced into a spine, an intercalated spine and a postorbital spine which is sometimes simple and sometimes cupped and occasionally armed with an accessory spine on the upper anterior edge near the base. Basal antennal article moderately broad and rectangular and frequently armed with spines at both anteromedial and anterolateral angles. Eyestalks of moderate length and generally slender; only the distal half is visible in dorsal view. Carapace pyriform and sometimes broad. Rostrum always of two distinct spines. Ambulatory legs generally of moderate length.

MITHRACINAE (81): Orbits extremely well developed with the eave and basal antennal article laterally expanded and usually tubular, completed behind by the prominent postorbital lobe which is often cupped. An intercalated spine is sometimes present. Eave sometimes forwardly produced into a preorbital spine or lobe, and sometimes prolonged posteriorly into an antorbital spine. Eyestalk moderately long but only the distal portion generally visible in either dorsal or ventral view. Carapace basically pyriform but anteriorly broadened due to expansion of orbits. Rostrum of two distinct spines which are often contiguous and sometimes fused into a broad lamella. Ambulatory legs seldom of great length.

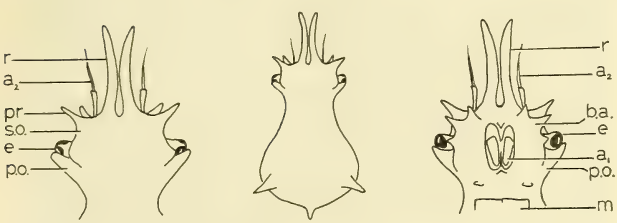
Figure 2. Generalised morphology of the subfamilies Pisinae, Majinae and Mithracinae. Arrangement and abbreviations as in text-fig. 1.



PISINAE



MAJINAE



MITHRACINAE

The seventh subfamily, the OREGONIINAE contains three genera which are boreal in distribution and not represented in Australia. They resemble the Inachinae in most features but are characterised by the terminally broadened male abdomen, the seventh segment being quadrate and deeply inserted into the sixth segment, and the longitudinally grooved male first pleopod, the groove being margined by rows of filamentous setae. A detailed treatment is given by Garth (1958).

IV. THE GENERA

The characters which are of value at the generic level are essentially the same as those used at the subfamilial level and already discussed. It need only be emphasised that the application of these characters at the generic level is invariably more rigorous than at the higher levels. Thus congeneric species are usually considered to share very similar orbital structure, form of the rostrum and of the male first pleopods and to agree in the number of free segments in the abdomen. They also generally resemble each other closely in carapace shape and ornamentation, form of the third maxillipeds, shape of the male abdomen (a character introduced by Shen in 1932) and often shape of the male chela but seldom in actual size and in relative length of the ambulatory legs.

The remaining part of this section and most of the succeeding one will be devoted to a discussion of the several lower taxa of the Australian Majidae which are considered to pose important problems at the present time.

Of the 24 majid genera listed by Haswell (1882c), ten now either have quite different meanings or are known under different names. These are as follows:

1. *Stenorhynchus* Lamarck. Of the three species included here by Haswell, two have been shifted to *Achaeus* and one, *S. curvirostris,* has not been collected since its discovery (see next section). Lamarck's genus is currently recognised for two species confined to the Americas and north-west Africa (Garth 1958, Garth & Holthuis 1963); since Haswell mentions the rostrum being formed of two spines, not one, it is reasonable to assume that he intended to refer to *Stenorhynchus* Latreille (now considered a synonym of *Macropodia* Leach, 1814).
2. *Halimus* Latreille. The species included here by Haswell are now known as species of *Naxia* Latreille, *Halimus* being a junior synonym of that genus. The composition of the abdomen (of both sexes) and several other characters in these species require investigation to determine their relationships to the New Zealand representative of the genus (Griffin, in press, b). The comparatively well developed orbits and distally expanded ambulatory propodi set this genus apart from other inachines. Haswell's subgenus *Microhalimus,* with its single species, *M. deflexifrons,* was included as a subgenus of *Naxia* by McCulloch (1908). For the sake of convenience, *Microhalimus* is here not given subgeneric status though it is true that *M. deflexifrons* appears to differ in some important features of the orbit from other species of *Naxia,* particularly in the number and arrangement of the spines above and behind the orbit. Such disagreement is especially obvious when it is compared with those species with which it agrees in the slight expansion of the ambulatory propodi.
3. *Naxia* H. Milne Edwards. Haswell listed one species under this genus, *Pisa serpulifer* Guérin. This was transferred to *Naxioides* A. Milne Edwards (of which *Naxia* Miers is a synonym) by Rathbun (1914) and later (Rathbun 1924) set apart in a genus of its own, *Paranaxia;* H. Milne Edwards's genus is a synonym of the latter.

4-6. *Gonatorhynchus* Haswell, *Paramithrax* H. Milne Edwards and *Chlorinoides* Haswell. *Gonatorhynchus* has recently (Griffin 1963b) been sunk in *Paramithrax* which has been recognised as monotypic. There appear to be some important similarities in orbital structure between *P. barbicornis* and *Anacinetops stimpsoni* although the species are at present placed in different subfamilies. The meaning attributed *Paramithrax* in Haswell's time has also been changed through the removal of several species to *Chlorinoides* (see Griffin in press, a). These latter species are the ones often placed in *Acanthophrys* A. Milne Edwards, a genus synonymous with *Hyastenus* White.

7-9. *Egeria* Latreille, *Cyclomaia* Stimpson and *Parathoe* Miers. These have been replaced respectively by *Phalangipus* Latreille, *Cyclax* H. Milne Edwards and *Perinia* Dana without change in meaning. In addition *Eucinetops* Stimpson no longer appears in the Australian lists, *Anacinetops* Miers having been accepted for *E. stimpsoni* Miers (see Balss 1935). One genus listed by Haswell among the Oxyrhyncha, the monotypic *Pleurophricus* A. Milne Edwards, has recently been included among the Cymopolidae (now known as the Palicidae—see Holthuis 1962: 244, 249) by Balss (1957: 1662) and is not treated here.

10. *Chorilibinia* Lockington. This genus was listed by Haswell under the name *Chlorolibinia;* it will be discussed in more detail at the end of this section.

A nomenclatural point which should be mentioned here concerns the genus *Camposcia*. Balss (1957: 1620) lists this as *Camposcia* Desmarest, 1823. Yaldwyn (pers. comm.) has kindly informed me that Desmarest's reference (*Dict. Sci. nat.* 28: 259, 262) is to an MS name of Leach, *Camposia*. Other authors before Latreille (1829) (in Cuvier's *Reg. Anim.* IV. (2): 60) also used this spelling. However, it appears that Latreille who used the name *Camposcia,* was the first to include a species in the genus. *Camposia* of Desmarest and others would, therefore, appear to be "nomen nudum." The species included in *Camposcia* Latreille, 1829 was *C. retuja* which was listed without comment by H. Milne Edwards (1834:283) as *Camposcia retusa* Latreille, 1829. All subsequent workers used these spellings which are therefore followed here.

Among other genera which need re-examination in regard to their distinctness and relationships are *Xenocarcinus, Zewa, Phalangipus, Doclea, Antilibinia, Hyastenus* and *Micippa*.

1. *Xenocarcinus* White. Sakai (1938: 324) has placed this genus in the subfamily currently known as the Mithracinae because he considers that at least two of the Japanese species show traces of an intercalated spine. Although this structure is unknown in the Acanthonychinae, *Xenocarcinus* is here placed in that subfamily because of its numerous resemblances to other acanthonychinines.

2. *Zewa* McCulloch. This genus was introduced in 1913 for a (new) species from north-eastern Australia. At the same time the earlier described *Pseudomicippe varians* Miers was included because, as McCulloch noted, previous workers had expressed some doubt about the wisdom of considering this latter species to be congeneric with *P. tenuipes* A. Milne Edwards. McCulloch considered the presence of a large lobe above the orbit and of a spine on the posterior border of the carapace important characters in this genus. Balss (1957), however, lists *Zewa* as a synonym of *Pseudomicippe* Heller. Although comparisons of descriptions and figures of the three species (see Buitendijk 1939: 255, pl. VIII figs. 3 and 4; and Sankarankutty 1962: 160, figs. 17-23 for *P. tenuipes*) certainly inclines me towards Balss's view, I retain McCulloch's genus pending a fuller investigation of the Australian species.

3. *Phalangipus* Latreille and *Doclea* Leach. These two genera are among those pisines in which positive identification of an intercalated spine is difficult. In both genera the eave is poorly expanded and separated by a more or less wide hiatus from the postorbital lobe. *Phalangipus* is usually regarded as possessing an intercalated spine and *Doclea* to be lacking it. Thus *P. australiensis,* which possesses a small denticle in the hiatus, is widely separated in the key from *D. profunda,* in which there is no denticle. But among species of *Doclea,* the South African *D. muricata* (Herbst) (see Barnard 1950: 49, fig. 11a) does possess such a denticle just forward of the postorbital lobe. Some re-arrangement of species may be necessary. Rather striking differences in carapace shape exist between the species of *Doclea* (see Sakai 1938: pl. XXXVII) just as in *Naxioides*.

4. *Antilibinia* Macleay. Three species are at present included in this genus, one each from South Africa, the Philippines and Australia. The last two were both described by Rathbun from a few specimens and have not been since discussed on the basis of additional material. Barnard (1950:37) doubted that the Australian *A. lappacea* belongs in the same genus as the South African *A. smithii* because of differences in carapace shape and length of the rostrum; he also considered that the latter species might well be shifted to the American *Taliepus* A. Milne Edwards, again because of similarities in carapace shape. Indeed both

Antilibinia and *Taliepus* have in the past been considered subgenera of *Epialtus* H. Milne Edwards (see Garth 1958:207). A new genus may be required for the Australian and Philippine species.

5. *Hyastenus* White. As the basis for Balss's (1929) Hyasteniinae, this extremely large genus (Balss in 1935 listed 38 species) is usually considered to be characterised especially by an absence of an intercalated spine from the orbit and by the distinctness of all seven abdominal segments. However, Laurie (1906) has noted that in his *H. irami* there is a distinct lobe between the eave and postorbital lobe. *H. convexus* Miers also appears to possess such a structure and many species of *Hyastenus* have on the upper anterior edge of the postorbital lobe a well developed accessory lobe. Sakai (1938:280) has pointed out that the abdomen of the female of *H. diacanthus* (de Haan) consists of only five segments. Such features are usually considered sufficient to warrant generic separation.

6. *Micippa* Leach and *Paramicippa* H. Milne Edwards. When *Paramicippa* was first set up in 1834, two species, *Micippa platipes* Rüppell and *P. tuberculosa* Milne Edwards were included. The first was designated type species of *Paramicippa* by Miers (1879c: 662) and a definition of that genus given at the same time. The second species was alone included in *Paramicippa* in Miers's later revision of the two genera (Miers 1885). Such a procedure was quite invalid. Since *M. platipes* is now generally accepted as belonging to *Micippa* (Sakai 1938, Buitendijk 1939), *Paramicippa* should fall to that genus. If a separate genus is to be established for *P. tuberculosa* because of the pronounced bifid nature of its rostrum or its comparatively long eyestalk or for any other reason, a new name must be used. The situation awaits further investigation and *P. tuberculosa* is here included amongst species of *Micippa*.

Finally, among the genera introduced to the Australian lists in this paper, two require further mention; in one way they may be regarded as merely replacing names already in use.

1. *Scyramathia* A. Milne Edwards. In 1918 Rathbun placed *Hyastenus fultoni* Grant, 1905 in this genus which has recently been recognised as a synonym of *Rochinia* A. Milne Edwards (Garth 1958: 282). Examination of material of Grant's species (11 specimens including relatively large males and females from the Australian Museum's collections: reg. no. P.4515, 20 miles east of Babel I., Tasmania, 65-70 fms., "Endeavour" Expedition) reveals the male first pleopod as being of the "pisoidiform" type (Garth 1958:249; see also his pl. Q) with a truncate but poorly expanded apex and similar to that of *Rochinia occidentalis* (Faxon) (see Garth 1958: pl. Q fig. 7). *H. fultoni* also resembles this species in shape and type of ornamentation of the carapace, relative length of the rostrum, form of the orbit and in several other features (see Rathbun 1925: pls. 228, 229 fig. 5). It seems to fit very satisfactorily into *Rochinia* which genus is now added to the Australian fauna. In the Indo-West-Pacific, species of *Rochinia* are known also from Japan, India and South Africa.

2. *Chorilibinia* Lockington. Garth (1958: 282) has recently orphaned the Australian and New Guinean *C. gracilipes* Miers, 1879 and the Indian *C. andamanica* Alcock, 1895 by the transference, to the mithracine *Stenocionops* Desmarest, 1823, of *Chorilibinia angusta* Lockington, 1877, type species (by monotypy) of *Chorilibinia* Lockington, 1877. The Indian and Australian species are completely different from *C. angusta* and resemble species of *Libinia* Leach and *Libidoclea* H. Milne Edwards & Lucas among the American Pisinae. However, examination of *C. gracilipes* (numerous specimens including relatively large males and females from the Australian Museum's collections; reg. no. P. 14931, Albany Passage, N. Queensland, Melbourne Ward, August 1928) shows that it differs from such American species in two important characters. First, the female abdomen comprises only five free segments (fourth to sixth inclusive fused) in contrast to the seven of *Libinia* and *Libidoclea*. Secondly, the male first pleopod is of the pisoidiform type with a tapered, acute apex and subterminal aperture in contrast to the scyriform type possessed by the American species. *C. andamanica* and *C. gracilipes* resemble each other in structure of the orbit, form of the rostrum, shape of the carapace and comparative length of the ambulatories; *C. andamanica* also has a five-segmented abdomen in the female (Alcock 1895). The form of the male first pleopod

is unfortunately unknown for the Indian species. A new genus thus seems to be required for these two Indo-West-Pacific species. The name *Chlorolibinia* published by Haswell (1882:17) is surely a mistake for Lockington's genus as the latter's name follows the name of the genus. Being an incorrect subsequent spelling, *Chlorolibinia* is unavailable for use under article 33 (b) of the International Code of Zoological Nomenclature. The name *Austrolibinia* is therefore proposed and the genus is diagnosed below.

AUSTROLIBINIA n. gen.

Chorilibinia Lockington; Miers 1879b: 7; (part: *C. gracilipes* Miers, 1879). Alcock 1895: 221 (part: *C. andamanica* Alcock, 1895).

Chlorolibinia Haswell, 1882c: 17; incorrect subsequent spelling of *Chorilibinia* Lockington, 1877.

Carapace pyriform, armed with a few slender spines and bearing posteriorly a broad, medially acute lobe. Rostrum united in basal half, consisting distally of two acute, divergent spines. Supraorbital eave well expanded, anterolaterally and posterolaterally acute, separated from the large, cupped postorbital lobe by a very narrow fissure; intercalated spine absent. Basal antennal article of moderate width, provided with a prominent lobe laterally at its base. Ambulatory legs long and slender, the first about twice carapace length. Chelipeds shorter than the first ambulatory leg in both sexes, chelae moderately inflated in male. Abdomen of seven segments in the male, of five in the female, fourth to sixth fused. First pleopod of male slender, tapering, apically acute, aperture subterminal (based on *C. gracilipes* only).

Type species: *Chorilibinia gracilipes* Miers, 1879.

V. THE SPECIES

The characters which are of value at the specific level are for the most part different in each genus. For instance, in the genus *Notomithrax*, the form of the crests on the carpus of the cheliped is of importance; in nearly all majines the number and arrangement of the spines on the carapace are a reliable guide but appear to be of little use in many pisines. Several characters which are widely used at the specific level unfortunately differ with age and/or sex. These include the shape of the chela and abdomen which change with growth, often in a single moult, and also differ according to sex; relative proportions of the carapace and length of the spines which change with growth, the carapace becoming wider (particularly in pisines and majines) and the spines shorter and blunter; and the number of free segments in the abdomen which is often different in males and females of the one species. In *Huenia* species the shape of the carapace is strikingly different in males and females. Cases in which sexual dimorphism has resulted in the original description of two species, one based on the male and one on the female, are, as in other groups of animals, not infrequent. The shape of the merus of the third maxilliped and of the basal antennal article are often used diagnostically but in some species the degree of spinulation or tuberculation of these two structures may change during growth.

Among the 45 species listed by Haswell (1882c), 16 have since suffered specific name changes. Some of these have been mentioned in the preceding section. Some species, particularly among the Acanthonychinae, are now recognised as highly polymorphic so that numerous names are reduced to a single valid one. This is true, for example, in the genera *Oncinopus* de Haan, *Menaethius* Latreille and *Huenia* de Haan, although the number of Australian species currently recognised is the same as that listed by Haswell. Specific name changes have taken place, since Haswell's time, particularly in the genera *Naxia* Latreille, *Chlorinoides* Haswell, *Micippa* Leach and *Tiarinia* Dana (see references in key). Special mention should be made of the relatively recent recognition that *Platymaia wyvillethomsoni* Miers is a western Pacific species distinct from the Indian Ocean *P. alcocki* Rathbun (*P. wyvillethomsoni* of Alcock and later authors) (Rathbun 1918); Calman's (1900) Torres Strait material of *Xenocarcinus tuberculatus* is correctly referable to *X. depressus* Miers (Gordon 1934, Sakai 1965), whilst *Xenocarcinus tuberculatus* is a western Pacific species distinct from the Indian Ocean *X. alcocki* Laurie (Sakai 1965); *Paramicippa hispida* Baker (*Eruma hispida* of McCulloch) is synonymous with *Anacinetops*

stimpsoni Miers (Balss 1935); *Schizophyrs dama* (Herbst) is a western species in Australia distinct from the widespread *S. aspera* (H. Milne Edwards) (Balss 1935, Yaldwyn 1964); *Cyclax spinicinctus* Heller (? = *C. perryi* Dana) is distinct from *C. suborbicularis* (Stimpson) (Forest & Guinot 1961); *Micippa platipes* Rűppell and *M. philyra* (Herbst), often considered synonymous, are in fact distinct (Buitendijk 1939); *Notomithrax ursus* (Herbst) includes *Paramithrax latreillei* Miers (Bennett 1964, Griffin 1963a) and definitely occurs in Australia (McNeill 1953); the Australian material of *Paramithrax peronii* mentioned by Haswell (1882c) is correctly referable to *Notomithrax minor* (Filhol) (Bennett 1964); *Leptomithrax australiensis* Miers and *L. spinulosus* Haswell are both synonyms of *L. gaimardii* (H. Milne Edwards) (Griffin 1963b); *Achaeus fissifrons* (Haswell) includes *A. tenuicollis* Miers (Griffin and Yaldwyn 1965); and that *Sargassocarcinus foliatus* Ward also occurs in Japan where it has been known under the older but generically inaccurate name of *Mimulus cristatus* Balss (Sakai 1965). In this paper advantage is taken of the remarks of previous carcinologists to consider *Cancer aragnoides* Rumphius (specific name misspelt *arachnoides* by later workers), *Cancer longipes* Linnaeus, *Egeria indica* Leach and *E. herbstii* H. Milne Edwards a single species, *Phalangipus longipes* (Miers 1884: 182, Alcock 1895: 224 and Grant & McCulloch 1906: 27). Similarly, *Naxia cerastes* Ortmann is considered synonymous with *Naxia taurus* Pocock and included as *Naxioides taurus* (Alcock 1895: 220, Calman 1900: 37). Both these species need investigation.

It is brought out later in this paper that a large number of species considered to be restricted to Australia have been recorded only once from little material. Nothing is to be gained by listing these—material of all is to be eagerly sought. Only two are mentioned here as they are not included in the key.

1. *Stenorhynchus curvirostris* A. Milne Edwards, 1873. This was recorded from Bass Strait and the original description was repeated by Haswell (1882c: 2). I am unable to confidently place it in a genus but it should key out somewhere near *Achaeus* or *Achaeopsis;* Miers (1886: 6, 18) tentatively placed it in *Achaeopsis.* As already indicated (see preceding section) it may belong in *Macropodia* which so far is unknown from Australia.
2. *Inachus australis* Gray, 1831. This was not listed by Haswell. Gray's description was very short and I am unable to comment on the relationships of the species; Gray mentions that it is "somewhat allied" to *Inachus arabicus* Rűppell (a synonym of *Menaethius monoceros* Latreille) whilst Miers (1886:19) considered that it might belong in *Chlorinoides.*

Special difficulties in satisfactory delineating species appear to have been concentrated in a few genera, most of which still await study. Three require mention here:

1. *Hyastenus.* Many species appear to show rather wide geographic or age variation in ornamentation of the carapace and relative length of the rostral spines. Yet both these characters were heavily relied upon by Alcock (1895) whose arrangement is largely followed here because it is these features which have most often been mentioned in descriptions in the literature. Buitendijk (1939) has illustrated the male first pleopods of several Australian species.
2. *Micippa.* Species of this genus also appear to show the kind of wide variation exhibited in *Hyastenus.* Characters such as the presence of knobs on the spines should be used with caution, as in *Chlorinoides.*
3. *Tiarinia.* Species of this genus are in at least as much confusion as those of any other. Only *T. angusta,* which stands out because of its spinulous rostrum, is easily recognised. The status of all other species is in doubt although descriptions and illustrations provided by Sakai (1938, 1965) and by Buitendijk (1939) are of assistance. The main requirement is definition of the species on the basis of the male first pleopod (as in many other species groups), followed by an analysis of the tuberculation and spinulation of the dorsal surface and margins of the carapace and their changes during growth. Measurements given by Buitendijk of three dimensions of the carapace in *T. cornigera* (Latreille) and *T. gracilis* Dana (of which the Australian and western Pacific *T. depressa* Stimpson may be a synonym) reveal no relative growth differences.

Only four other species need be mentioned.

1. *Entomonyx spinosus* Miers. This quite widespread Indo-West Pacific species, of which *Macrocoeloma nummifer* Alcock is a synonym, has been recorded only once from Australia (as *Acanthophrys spinosus* by Balss 1929). *Entomonyx* is resurrected as a monotypic genus to accommodate it (Griffin, in press, a).
2. *Criocarcinus superciliosus* (Herbst). This widespread Indo-West Pacific ophthalmine is included in the key on the basis of material from the Great Barrier Reef identified by F. A. McNeill (in prep.).
3. *Achaeus* sp. A single specimen in the Australian Museum's collections appears to constitute an unnamed species of *Achaeus*. Additional characters of this species have been given elsewhere (Griffin & Yaldwyn 1965).
4. *Chlorinoides goldsboroughi* Rathbun. This species, previously known only from Hawaii, is included in the key on the basis of two specimens in the Australian Museum's collections taken off New South Wales. Additional characters for separating this species from the closely related Japanese *C. brevispinosa* Yokoya have recently been given by Sakai (1965:88).

VI. THE KEY

The following key to genera and species includes all species recorded in the literature from Australian localities, with the exception of *Stenorhynchus curvirostris* and *Inachus australis* (see above).

Apart from the characters given for each taxon, the following information is also presented. In the case of genera, the name is followed by the world geographic range; references to important accounts of the genus as a whole, or merely of non-Australian species; and the approximate number of known valid species. In the case of species the name is followed by specific synonyms (as recorded in the Australian literature); size; distribution within Australia; distribution outside Australia; bathymetric range (for details of last four see below); further distinguishing characters or other information which may be of assistance in more positively identifying the species; and finally (in brackets), one or two references to descriptions and illustrations of the species. (Note: Six species are figured in this paper—pls. xv-xvii—and a reference to these is inserted in the appropriate part of the key. In the case of four species, *viz., Huenia bifurcata, Hyastenus auctus, Hyastenus sebae* and *Tiarinia elegans,* these are the first illustrations provided; that of *Paranaxia serpulifera* is the first illustration of an adult specimen). Where a genus is monotypic or represented in Australia by only a single species, the above information follows on immediately from the remarks concerning the genus.

Size: Relative size (total carapace length including rostrum) is indicated as follows: very small: less than 10 mm; small: 10-20 mm; medium: 20-40 mm; large: 40-80 mm; very large: more than 80 mm.

Australian distribution: The Australian coastline is divided into six regions for the purposes of this review. SE (south east): Tasmania, Victoria and New South Wales, or, more correctly, Kangaroo Island to Brisbane; NE (north east): remaining part of the eastern seabord; N (north): Torres Strait; NW (north west): remaining part of northern coastline to Shark Bay; SW (south west): west coast from Shark Bay and along south coast to Eucla; and S (south): rest of the Great Australian Bight to Spencer's Gulf. The divisions south and north are used here to emphasise the fact that some species are recorded from South Australia but not Victoria, or from Torres Strait but not the adjacent Barrier Reef or Gulf of Carpetaria; they are thus convenient divisions only and may have no real zoogeographic basis (see Section VII). It should be noted that this review treats only species recorded from the Australian mainland, Tasmania, the inshore islands off the western and eastern coastlines, New Guinea and Lord Howe Island.

Overseas Distribution: The grouping and designation of overseas localities in the main follows Ekman (1953). Thus the tropical to warm temperate area of the Indian and western Pacific Oceans are considered to comprise the following faunal subregions (outside Australia): Indian Ocean; Indo-Malaya (including the Philippines); tropical and subtropical Japan (designated simply as Japan); central Pacific (excluding Hawaii); and Hawaii. Taxa, the distribution of which extends through the Indian Ocean and Japan and any other subregion, are designated in the key as Indo-West Pacific.

Bathymetric Distribution: The depth at which species occur is divided into five categories: littoral: intertidal; sublittoral: down to 10 fms; shallow offshore: 10-50 fms; lower shelf: 50-100 fms; and slope: over 100 fms. In the case of species which extend down the slope, the deepest recorded occurrence is given.

Finally, an attempt has been made in the key, at least at the generic level and above, to use as far as possible characters which are considered important from the phylogenetic point of view; in most cases ready separation is achieved. The key is set out with contrasting couplets adjacent so as to permit easier comparison of the divisions.

KEY TO SUBFAMILIES OF MAJID BRACHYURA AND AUSTRALIAN GENERA AND SPECIES

1 Eyes either without orbits, or with incomplete or commencing orbits. Basal antennal article rather slender 2

— Eyes with nearly complete, or complete, orbits. Basal antennal article very broad 61

2(1) Male abdomen terminally broadened, seventh segment sub-quadrate and inserted deeply into sixth segment. Male first pleopod longitudinally grooved, with rows of filamentous setae on either side of groove .... Subfamily OREGONIINAE

— Male abdomen not terminally broadened, seventh segment sub-triangular and not inserted deeply into sixth segment. Male first pleopod exceedingly varied but not as in Oregoniinae ... 3

3(2) Eyes without orbits; eyestalks generally long, either non-retractile, or retractile against an acute postorbital spine affording no concealment. Basal antennal article extremely slender and usually long . . . . Subfamily INACHINAE 4

— Eyes with incomplete or commencing orbits. Basal antennal article not extremely slender 24

4(3) Seven free abdominal segments in male and usually in female 5

— Abdomen of six or fewer segments in both sexes 15

5(4) Carapace circular or subcircular. Rostrum appearing trispinose, interantennular spine forwardly projecting and visible from above. Postorbital lobe a prominent spine. Basal antennal article cylindrical. Ambulatory legs very long, the longest more than 3 times carapace length 6

— Carapace pyriform or triangular, never circular. Interantennular spine not visible from above. Postorbital lobe spinous or absent. Basal antennal article flattened. Ambulatory legs variously elongate, never more than 2¼ times carapace length 7

6(5) Interantennular spine projecting well beyond rostrum. Ambulatory propodi flattened, oar-like. Chelipeds not very long, less than one-third length of ambulatories in adult male, palm in male inflated, widest about midway along. No long protogastric spines . . . . *Platymaia* Miers, 1886
Indo-West Pacific, 6: *P. wyvillethomsoni* Miers, 1886; medium; in Australia known only from four localities near Eucla, Great Australian Bight (SW); Indo-Malaya, C. Pacific, Japan; lower shelf and slope to 400 fms; further distinguished by spine on upper anterior margin of postorbital lobe (Rathbun, 1918: 7, pls. III, IV, XIV).

— Interantennular spine scarcely, if at all, exceeding rostrum. Ambulatory propodi cylindrical. Chelipeds very long, as long as ambulatories in adult male, palm in male widest distally. Protogastric regions each with a very long, forwardly directed spine . . . . *Cyrtomaia* Miers, 1886
Indo-West Pacific, 13: *C. maccullochi* Rathbun, 1918; medium to large; known only from near Eucla, Great Australian Bight (SW) in 190-450 fms; further distinguished by cylindrical basal segments of antennal flagellum and long rostral spines (Rathbun 1918: 4, figs. 1, 2, pls. 1, 2).

7(5) Rostrum very short, less than 1/8 postrostral carapace length, of two rounded or blunt lobes. Carapace smooth 8

— Rostrum long, at least 1/5 postrostral carapace length, of two acute spines. Carapace with scattered tubercles 10

8(7) Eyestalks small, retractile beneath edge of carapace. Supraorbital eave unexpanded, without lobes or spines. Ambulatory legs slender and moderately long, propodi 1 & 2 dilated and compressed, dactyli of all ambulatories subchelate . . . . *Oncinopus* de Haan, 1839.
Widespread Indo-West Pacific; monotypic: *O. aranea* de Haan, 1839 (= *O. subpellucidus* Stimpson, 1857; *O. angulatus* Haswell, 1880); small; S, SE, NE, N; littoral to shallow offshore; carapace weakly calcified (Hale 1927: 125, fig. 122; Sakai 1965: 66, pl. 27, fig. 1).

— Eyestalks very long. Supraorbital eave variously expanded. Ambulatory legs variously elongate, cylindrical 9

9(8) Ambulatory legs long, the first twice carapace length, slender. Supraorbital eave unexpanded, lacking lobes or spines. Basal antennal article very slender. Third maxillipeds with merus narrower than ischium . . . . *Camposcia* Latreille, 1829
Widespread Indo-West Pacific, monotypic: *C. retusa* Latreille, 1829; medium; NE, N, NW; littoral and sublittoral; often masked by seaweed and sponges (Barnard 1950: 12, fig. 1; Sakai 1965; 69, pl. 30, fig. 1).

— Ambulatory legs short, the first less than ½ carapace length, quite stout. Supraorbital eave moderately expanded with a small antorbital lobe; a prominent conical spine between eave and postorbital lobe separated from both by wide fissures. Basal antennal article moderately broad. Third maxillipeds with merus as wide as ischium . . . . *Anacinetops* Miers, 1879
Australia, Timor; monotypic: *A. stimpsoni* (Miers, 1879) (= *Paramicippa hispida* Baker, 1905); medium; S, NE, N; littoral (McCulloch 1913: 336, figs. 47, 48).

10(7) Abdomen showing no coalescence of segments. Orbits with eave unexpanded and unarmed except for a small, widely removed postorbital spine. Ambulatory legs long, cylindrical, first pair more than twice carapace length, stout . . *Ephippias* Rathbun, 1918
Restricted to Australia, monotypic: *E. endeavouri* Rathbun, 1918; very large; SE, S, SW, NW; shallow offshore (Rathbun 1918: 9, pl. 15).

— Abdomen sometimes, especially in female, showing coalescence of segments. Orbits with moderately expanded eave followed by one or two spines. Ambulatory legs of only moderate length, less than 1½ carapace length, generally slender, propodi distally expanded, compressed, dactyli subchelate . . *Naxia* Latreille, 1825 11
Australasia; see reviews by Baker (1905), McCulloch (1913), Balss (1935), Griffin (in press, b); 6; all species (except *N. deflexifrons*) figured by Hale (1927); all except *N. spinosa* restricted to Australia.

11(10) Ambulatory propodi weakly expanded distally. Supraorbital eave usually acute anterolaterally 12

— Ambulatory propodi strongly expanded distally. Supraorbital eave rounded anterolaterally, armed with a small spine posterolaterally 14

12(11) Supraorbital eave rounded anterolaterally and with a small spine posterolaterally. Carpus of cheliped smooth . . . . *N. deflexifrons* (Haswell, 1880)
Medium; SE; shallow offshore (McCulloch 1913: 330, pl. X figs. 1-4).

— Supraorbital eave acute both anterolaterally and posterolaterally. Carpus of cheliped ridged 13

13(12) Rostral spines stout, almost straight. Carpus of cheliped with lateral ridge rounded . . . . *N. aurita* (Latreille, 1825) (= *Halimus laevis* Haswell, 1880); large; SW, S, SE; littoral (Hale 1927: 129, fig. 127).

— Rostral spines slender, strongly curved outwards distally. Carpus of cheliped with lateral ridge proximally acute . . . . . *N. aires* (Guérin, 1825) (= *Halimus gracilis* Baker, 1905); medium; S, SE; littoral (Hale 1927: 129, fig. 128).

14(11) Anterolateral spine of basal antennal article laterally denticulate. Merus of cheliped weakly tuberculate dorsally . . . . *N. tumida* (Dana, 1851) (= *Halimus tumidus* var. *gracilis* Baker, 1905); medium; S, SE, NE; littoral (Hale 1927: 128, fig. 126).

— Anterolateral spine of basal antennal article unarmed. Merus of cheliped smooth . . . . *N. spinosa* (Hess, 1865) (= *Halimus truncatipes* Miers, 1879); large; SW, S, SE; Kermadecs; littoral (Hale 1927: 127, fig. 125).

15(4) Abdomen of six segments in both sexes. Carapace triangular 16

— Abdomen of five segments in female, of five or six in male. Carapace subpentagonal to subpyriform . . . . . *Paratymolus* Miers, 1879 21
Indo-West Pacific; See also Sakai (1938); 5.

16(15) A prominent postorbital spine. Rostrum generally of moderate length, about 1/3 postrostral carapace length, of two acute spines. Carapace with a few prominent spines . . . . . *Achaeopsis* Stimpson, 1857 .. 17
Indo-West Pacific, Atlantic, Mediterranean; see Sakai (1938); 6; key to species in Griffin (in press, b).

— No postorbital spine. Rostrum very short, less than 1/10 postrostral carapace length, of two generally blunt lobes. Carapace with a few tubercles but not spines . . . *Achaeus* Leach, 1817 18
Indo-West Pacific, E. Atlantic, Mediterranean; review of Australasian species in Griffin & Yaldwyn (1965); 20.

17(16) Rostral spines unarmed. Branchial margins with two prominent spines and a few spinules . . . *A. thomsoni* (Wyville-Thomson, 1873)
Small, SE, SW; South Africa, E. & W. Atlantic, Mediterranean; lower shelf and slope down to 1000 fms; further distinguished by spinous merus and carpus of cheliped (Hale 1927: 124, fig. 120).

— Rostral spines with 2 or 3 spinules laterally. Branchial margins with four prominent spines . . . *A. ramusculus* (Baker, 1906)
Small; in Australia known only from off Neptune I. (S), in 104 fms; New Zealand (Hale 1927: 124, fig. 121; Griffin in press, b, fig.).

18(16) Rostrum of two short, acute spines. Supraorbital eave bearing laterally a prominent spine and several minute spinules . . . . *A. fissifrons* (Haswell, 1879) (= *A. tenuicollis* Miers, 1886); small; SE; New Zealand, Indo-West Pacific; shallow offshore and lower shelf (Griffin & Yaldwyn 1965: 38, figs. 1-8).

— Rostrum of two generally rounded lobes. Supraorbital eave sometimes with minute spinules but never with a prominent spine 19

19(18) Carapace smooth, lacking prominent tubercles. Dactyli of ambulatories 3 and 4 almost semicircular, ventrally spinulated for distal 2/3 . . . . *A. lacertosus* Stimpson, 1857 (= *A. breviceps* Haswell, 1880); small; SE, NE, NW; Indo-West Pacific; sublittoral (Stimpson 1907: 20, pl. III fig. 7).

— Carapace with at least two prominent tubercles on cardiac region. Dactyli of ambulatories 3 and 4 strongly falcate but not semicircular, ventrally spinulated for entire length 20

20(19) Rostrum of two strong lobes separated by a narrow V or U sinus, often weakly convergent distally. Intestinal region with a small tubercle . . . . . *A. brevirostris* (Haswell, 1879) (= *A. affinis* Miers, 1884); small; SE, NE, N, NW; Indian O., Indo-Malaya; sublittoral to shallow offshore (Haswell 1880a: 432, pl. XXVII fig. 5).

— Rostrum of two pointed lobes, each with a small, sharp, distal projection. Intestinal region without a tubercle . . . *Achaeus* sp. Known only from a single small female taken off Cairns (NE) in 28 fms. (Griffin & Yaldwyn 1965:38).

21(15) Carapace with protogastric regions each bearing a strong tubercle; branchial margin also with a tubercle or spine 22

— Carapace smooth dorsally and without spines posterolaterally on branchial margin 23

22(21) Palm of chela dorsally prolonged into a terminal spine. Merus of cheliped with four ventral spines . . . . . *P. bituberculatus* Haswell, 1880 (= *P. bituberculatus* var. *gracilis* Miers, 1884); very small; restricted to Australia, NE; sublittoral (Haswell 1880c: 303, pl. XVI figs 1, 2).

— Palm of chela not prolonged into a terminal spine. Merus of cheliped unarmed . . . . *P. pubescens* Miers, 1879 Very small; N; Indo-West Pacific; sublittoral to shallow offshore (Miers 1879a: 45, pl. 2 figs 6, 6a, b; Sakai 1965: 66, pl. 26 figs. 3, 4).

23(21) Palm of chela smooth. Merus of cheliped smooth dorsally and with two tubercles ventrally . . . *P. sexspinosus* Miers, 1884 Very small; NE, N; Indian O., Japan; sublittoral (Miers 1884: 261, pl. XXVII figs., B, b, b^1).

— Palm of chela dorsally spinulous, outer surface with granulations and spinules. Merus of cheliped with numerous spinules dorsally and a few ventrally . . . . . *P. latipes* Haswell, 1880 (= *P. latipes* var. *quadridentata* Baker, 1906); small; restricted to Australia, SE, S, SW; sublittoral (Hale 1927: 123, fig. 119).

24(3) Eyes without true orbits, lacking a postorbital cup. Eyestalks variously elongate 25

— Eyes with commencing orbits having, in addition to the supraorbital eave which is sometimes produced into a preorbital spine, a large cupped postorbital process into which the eyestalk retracts. Eyestalks short . . . . . Subfamily PISINAE 36

25(24) Eyestalks long, orbit partially protected by a hornlike supraorbital spine or by a jagged postorbital tooth or by both . . . . . Subfamily OPHTHALMIINAE 26

— Eyestalks short, little moveable and either concealed by a preorbital spine or sunk in sides of rostrum . . . . . Subfamily ACANTHONYCHINAE 29

26(25) Supraorbital eave hardly expanded and bearing only a small antorbital spine. Rostrum of two weakly curved spines less than 1/3 postrostral carapace length. Branchial margin with small tubercles or unarmed . . . *Zewa* McCulloch, 1913 27
Australia, Japan; see McCulloch (1913), Sakai (1938); 4; Australian species, both of which are not known overseas, lack prominent marginal branchial tubercles.

— Supraorbital eave prominently expanded with a strongly developed antorbital spine and/or preorbital spine. Rostrum either of two straight spines 2/3 postrostral carapace length or of two exceedingly short and strongly curved spines. Branchial margins with 2-3 long spines 28

27(26) Postorbital lobe with a strong tubercle. Posterior intestinal margin rounded . . . . *Z. varians* (Miers, 1879)
Medium; SE, NE, N, NW; sublittoral (Calman 1900: 39, pl. 2 figs. 25, 26).

— Postorbital lobe without an anterior tubercle. Posterior intestinal margin with a strong medial tubercle . . . . .
Z. banfieldi McCulloch, 1913
Medium; known only from near Cairns (NE); littoral (McCulloch 1913: 332, pl. X figs. 5, 6).

28(26) Supraorbital eave rounded anteriorly, antorbital spine greatly elongated. Rostral spines widely separated, straight, 2/3 postrostral carapace length. Branchial margins with 3 spines . . . . .
Picroceros A. Milne Edwards 1865
N. Caledonia, Lord Howe, N. Hebrides, Japan; monotypic: *P. armatus* A. Milne Edwards, 1865; very large; NE; sublittoral; further distinguished by single gastric spine and single posterior intestinal spine; carapace spines sometimes knobbed (Sakai 1938: 247, fig. 24; pl. XXV fig. 2).

— Supraorbital eave with strongly developed, subequal preorbital and antorbital spines. Rostral spines arising close together, strongly curved outwards, less than 1/6 postrostral carapace length. Branchial margins with two spines . . . . . .
Criocarcinus H. Milne Edwards, 1834
Indo-West Pacific; monotypic: *C. superciliosus* (Herbst, 1803); large; known in Australia only from Low Isles, Great Barrier Reef (NE) (to be reported elsewhere by F. A. McNeill); littoral (A. Milne Edwards, 1872: 242, pl. 12 fig. 3; Sakai 1938: 251, text-fig. 26).

29(25) Rostrum of two spines separate from base. A forwardly produced preorbital spine and a postorbital spine both present. Abdomen in female of 6 or 7 free segments 30
Rostrum single or only distally bifid. Preorbital spine present or absent, postorbital spine absent. Abdomen in female of only 5 free segments 31

30(29) Rostrum short, less than ¼ postrostral carapace length. Branchial margin with a prominent spine or lobe . . . *Pugettia* Dana, 1851
Indo-West Pacific and E. Pacific to California, 18: *P. mosaica* Whitelegge, 1900; small; restricted to Australia, SE; shallow offshore to lower shelf; further distinguished by strongly granulated carapace and dorsally narrow postorbital lobe (Whitelegge 1900: 141, pl. XXXV figs. 5-7).

— Rostrum moderately long, more than 1/3 postrostral carapace length. Branchial margin lacking a lobe or spine . . . . .
Antilibinia Macleay, 1838
South Africa, Philippines and Australia, 3: *A. lappacea* Rathbun, 1918; small; known only from Great Australian Bight (SW) near Eucla in 200-300 fms; further distinguished by prominent hepatic spine and length of rostral spines and preorbital spine (Rathbun 1918: 12, fig. 3; pl. vii fig. 3).

31(29) Supraorbital eave with a strong, forwardly directed preorbital spine. Branchial regions, at least, with prominent lateral expansions. Rostrum slender, abdomen in male of 7 free segments 32

— Orbit with a weakly expanded eave lacking spines. Margins of carapace weakly expanded. Rostrum a stout "beak." Abdomen in male of only 5 free segments . . . . .
Xenocarcinus White, 1847 35
Indo-West Pacific, 5; see Gordon (1934), Sakai (1938, 1965); upper orbital margin may be weakly notched once or twice.

32(31) Rostrum distally acute or bifid, either downwardly deflexed and depressed, or horizontal, compressed and vertically deep. Carapace smooth or with only a few (1-5) tubercles dorsally. Hepatic margin, at least in female, prominently expanded 33

— Rostrum distally acute, horizontal and depressed, vertically shallow. Carapace with numerous scattered tubercles dorsally. Hepatic margin not prominently expanded in either sex . . .
Menaethius H. Milne Edwards, 1834
Widespread Indo-West Pacific; monotypic: *M. monoceros* (Latreille, 1825); small; NE, N, NW; littoral (Barnard 1950: 43, figs. 9 g, h; Sakai 1965: 74, pl. 33 fig. 4).

33(32) Hepatic expansions well developed in both sexes and separated from branchial expansions by a shallow concavity or closed fissure. Rostrum downwardly deflexed . . . . .
Sargassocarcinus Ward, 1936
Australia, Philippines and Japan; see Sakai (1965); 2: *S. cristatus* (Balss, 1924) (= *S. foliatus* Ward, 1936); small; in Australia known only from Lindeman I., Whitsunday Passage (NE); Japan; littoral; further distinguished by sharply carinate and lobate ambulatory legs (Ward 1936: 9, pl. III figs. 4-6; Sakai 1965: 77, text-figs. 11a, b, pl. 34 fig. 3).

— Hepatic expansions well developed in female and clearly separated by a wide fissure from branchial expansions, poorly developed in male. Rostrum horizontal . . . . *Huenia* de Haan, 1839 34
Widespread Indo-West Pacific, 3; species show extreme variation in carapace shape, particularly between sexes.

34(33) Rostrum distally simple and acute. Branchial expansion rounded, subacute, or sometimes bilobed . . . *H. proteus* de Haan, 1839
Medium; S, NW, N; widespread Indo-West Pacific; littoral, (Hale 1927: 133, fig. 132; Barnard 1950: 41, figs. 9 a-f; Sakai 1965: 75, pl. 34 figs. 1, 2).

— Rostrum distally bifid. Branchial expansion bi- or trilobed.
H. bifurcata Streets, 1870
Medium; restricted to Australia, SE; littoral; distally bifid rostrum appears most reliable character (Haswell 1882c: 8). Figured here pl. XV, figs. d, e.

35(31) Carapace uneven, bearing several very prominent tubercles. Rostrum distally notched. Ambulatory legs smooth . . . . .
X. tuberculatus White, 1847
Medium; NE; Hong Kong, Japan; littoral and shallow offshore (Sakai 1965: 91, text-fig. 13, pl. 42 fig. 5).

— Carapace depressed, bearing a few indistinct granules. Rostrum deeply bifid. Ambulatory legs tuberculate . . . . .
X. depressus Miers, 1874
Small; SE, N; Indo-Malaya, N. Caledonia, Japan; littoral (Gordon 1934: 70, fig. 36 a-d).

36(24) Intercalated spine present 37
— Intercalated spine absent 43

37(36) Abdomen of seven segments in both sexes. Carapace pyriform. Supraorbital eave laterally expanded. Ambulatory legs generally short, seldom more than twice carapace length, usually less 38

— Abdomen of seven segments in male, of five in female. Carapace subtriangular. Supraorbital eave almost unexpanded laterally. Ambulatory legs extremely long and slender, the first three times carapace length . . . . *Phalangipus* Latreille, 1825 42
Indo-West Pacific; Rathbun (1916); 6.

38(37) Rostrum without an accessory spinule. Carapace variously smooth or granular, tuberculate or spinous. Ambulatory legs little longer than carapace 39

— Rostrum with an accessory spinule not far from tip. Carapace with well defined granules, spinules and spines. First ambulatory legs at least 1½ times carapace length . . . .
Naxioides A. Milne Edwards, 1865 41
Indo-West Pacific, 9.

39(38) Carapace, broad, smooth or granular. Basal antennal article broad, bearing two strong spines distally, one medial and one lateral *Herbstia* H. Milne Edwards, 1834
E. & W. central America, S.E. Atlantic, Mediterranean, Australia; see Garth (1958), Rathbun (1918), 10: *H. crassipes* (A. Milne Edwards, 1873); known only from Bass Strait (SE) in unknown depth; further distinguished by absence of spines on lateral margin of carapace (Haswell 1882: 12, no fig.).

— Carapace narrow, dorsally bearing numerous rounded tubercules. Basal antennal article slender, truncate distally or bearing anterolaterally a lobe or spine 40

40(39) Supraorbital eave rounded anterolaterally. Tubercles of carapace arranged in distinct groups. Rostral spines widely separated from base . . . . *Eurynome* Leach 1817
Indo-West Pacific, E. Atlantic, Mediterranean; genus reviewed in Griffin (1964), 8-9: *E. granulosa* Baker 1906; very small; known only from "South Australian coast" in 100-104 fms. (Griffin 1965:30, figs. 1-5).

— Supraorbital eave produced into a strong, forwardly directed spine. Tubercles of carapace scattered. Rostral spines fused basally *Tylocarcinus* Miers, 1879
Widespread Indo-West Pacific; 2: *T. styx* (Herbst, 1803); small; N, NE; Indo-West Pacific; littoral; further distinguished by spinous ambulatory meri and denticulate dactyli (Sakai 1938: 271, pl. XXXVI fig. 5).

41(38) Rostral spines about ¾ postrostral length of carapace, divergent from base. Dorsal surface of carapace with numerous tubercles sometimes enlarged into straight spines in mid-dorsal regions . . .
N. taurus (Pocock, 1890)
(? = *N. cerastes* Ortmann, 1894); small; N; Indian Ocean, shallow offshore (Alcock 1895: 219-20; Alcock & Anderson 1897: pl. XXXIII figs. 2-2a, 5-5a).

— Rostral spines as long as postrostral length of carapace, subparallel basally, weakly divergent distally only. Dorsal surface of carapace with numerous large, curved spines . . . *N. robillardi* Miers, 1882
Very large; SE; Mauritius, China S.; shallow offshore (Miers 1882: 339, pl. 20).

42(37) Median suborbital tooth much deflexed and bounded by a broad U sinus on both sides. Lobe on first abdominal segment in both sexes arcuate and occupying nearly whole width of segment . . . *P. australiensis* Rathbun, 1918
Small; restricted to Australia, known only from Platypus B. (NE) in 7-9 fms; further distinguished by absence of accessory spinule on rostral spines (Rathbun 1918: 15, pl. VI).

— Median suborbital tooth bounded by a V-sinus on both sides. Lobe on first abdominal segment in both sexes small, almost pointed, occupying much less than whole width of segment . . . *P. longipes* (Linnaeus, 1767)
(= *"Egeria Aragnoides"* Rumphius, 1705; *E. herbstii* H. Milne Edwards, 1834); small; NE, N; Indian Ocean; shallow offshore; carapace generally prominently spinous (Haswell 1882: 12—no recent fig.).

43(36) Abdomen of seven segments in both sexes. Rostral spines generally distinct from base. Carapace with slender spines or tubercles. Ambulatory legs generally long, if short then carapace weakly tuberculate 44

— Abdomen in male of seven segments, of five segments in female. Rostral spines basally coalescent. Carapace with stout spines, ambulatory legs short or carapace with slender spines, ambulatory legs long 60

44(43) Rostral spines slender, in length at least 1/6 postrostral portion of carapace and usually longer. Supraorbital eave not in close contact with postorbital lobe 45

— Rostral spines stout, in length less than 1/6 postrostral portion of carapace. Supraorbital eave separated from postorbital lobe by an extremely narrow fissure or completely coalesced with it . . 59

45(44) Supraorbital eave rounded anterolaterally and posterolaterally. Carapace completely smooth. *Micippoides* A. Milne Edwards, 1873
Widespread Indo-West Pacific; monotypic: *M. angustifrons* A. Milne Edwards, 1873 (= *Hyastenus andrewsi* Calman, 1909); small; E. New Guinea; littoral; further distinguished by weakly denticulate ambulatory dactyli, body and legs covered by very long hair (Calman 1909: 711, pl. LXII figs. 6, 7).

— Supraorbital eave at least anterolaterally acute, sometimes produced into a preorbital spine. Carapace with several prominent spines and/or tubercles or else granular 46

46(45) Supraorbital eave separated from postorbital lobe by a broad U sinus, posterolaterally unarmed, anterolaterally armed with a strong preorbital spine. Rostral spines fused for a short distance basally. Basal antennal article distally truncate . . . . *Rochinia* A. Milne Edwards, 1875
Indo-West Pacific and E. Pacific, Atlantic and Mediterranean; see Garth (1958); 18: *R. fultoni* (Grant, 1905) n. comb.; medium; restricted to SE Australia; lower shelf and slope to 300 fms.; further distinguished by 1 medial gastric, 1 medial cardiac, 1 medial intestinal and 1 lateral branchial spine (Rathbun 1918: 14, pl. V).

— Supraorbital eave posterolaterally acute, separated from postorbital lobe by a wide V or sometimes U sinus, anterolaterally acute but seldom produced. Rostral spines separated from base. Basal antennal article with an anterolateral spine or lobe . . . *Hyastenus* White, 1847 47
Tropical Indo-Pacific; list of species in Balss (1935): 38.

47(46) Denuded carapace with dorsal surface bearing numerous tubercles or spines and erosions 48

— Denuded carapace with a few spines or tubercles, often smoothly polished 49

48(47) Rostral spines as long as postrostral portion of carapace. Surface of carapace eroded but indistinctly tuberculate . . .
H. sebae White, 1847
Small; N, NW; Indian O., Indo-Malaya; sublittoral (Alcock 1895: 213). Figured here pl. XV, figs. b, c.

— Rostral spines about ½ postrostral carapace length. Surface of carapace distinctly tuberculate . . . .
H. oryx A. Milne Edwards, 1872
Medium; NE, N, NW, SW; Indian O., Indo-Malaya; sublittoral to shallow offshore (A. Milne Edwards 1872: 250, pl. XIV fig. 1; Haswell 1882:20).

49(47) Rostral spines less than 1/5 postrostral portion of carapace 50

— Rostral spines at least 1/3 postrostral carapace length and generally longer 52

50(49) Gastric regions with three medial tubercles; a prominent medial tubercle on cardiac region and on posterior intestinal margin; dorsal surface otherwise with several tubercles laterally . . . .
H. verrucosipes (Adams & White, 1848)
Small; in Australia known only from Torres Strait in 15-20 fms; Indo-Malaya (Calman 1900: 36, pl. 2 figs. 23, 24).

— Gastric region with a single tubercle medially, dorsal surface otherwise with some tubercles laterally but none mid-dorsally 51

51(50) Rostral spines outwardly curved distally . . . . .
H. minimus Rathbun, 1924
Very small; restricted to Australia, known only from C. Jaubert (NW) in 5-7 fms. (Rathbun 1924: 4, fig. 1).

— Rostral spines subparallel, weakly curved inwards distally.
H. planasius (Adams & White, 1848)
Medium; in Australia known only from Pt. Denison (NE); New Guinea, Indian O., Indo-Malaya; shallow offshore (Adams & White, 1848: 9, pl. ii figs. 4, 5; Alcock 1895: 212).

52(49) Branchial regions with a spine close to lateral margin, at widest part of carapace, markedly longer than any other spine or tubercle except rostral spines 53

— Branchial regions with a small tubercle or spine close to lateral margin, at widest part of carapace, little longer than other tubercles of carapace 55

53(52) Gastric regions with two medial tubercles or spines, cardiac region with a central tubercle. Rostral spines sinuous . . . .
H. spinosus A. Milne Edwards, 1872
Large; in Australia known only from Torres Strait in 5-7 fms; South Africa, Fiji (Barnard 1950: 53, fig. 11f).

— Gastric regions with a single medial tubercle; cardiac region without a tubercle. Rostral spines straight 54

54(53) Intestinal region without a tubercle. Lateral branchial spine without a subdorsal tubercle in front of it . . . . .
H. diacanthus (de Haan, 1839)
Large; SE, NE, N, NW, SW; widespread Indo-West Pacific sublittoral to shallow offshore; rostrum in female often shorter than in male, lateral branchial spine often greatly reduced, abdomen of female of 5 segments (Alcock 1895: 210; Sakai 1965: 81, pl. 36 fig. 1).

— Intestinal region with a strong tubercle. Lateral branchial spine with a tubercle above and in front of it . . . .
H. auctus Rathbun, 1916
Small; in Australia known only from near C. Jaubert (NW) in 12-14 fms; Philippines (Rathbun 1916: 543). Figured here, pl. xv, fig. a.

55(52) Carapace strongly tuberculate. Rostral spines almost as long as postrostral carapace length . . . . *H. brockii* de Man, 1888
Medium; in Australia known only from Torres Strait (N); Indian O., Indo-Malaya; sublittoral (de Man 1888: 221, pl. 7 fig. 1).

— Carapace weakly tuberculate or granular or sometimes smooth. Rostral spines usually ½ postrostral carapace length, sometimes longer 56

56(55) Rostral spines 2/3 postrostral carapace length. A single medial gastric tubercle and several granules laterally . . . . .
H. borradailei (Rathbun, 1907)
Medium; in Australia known only from C. Jaubert (NW); Indo-West Pacific; sublittoral to shallow offshore; further distinguished by 5 gastric granules in a transverse row, body covered by a thick tomentum (Rathbun 1911: 251, pl. 20 fig. 5).

— Rostral spines ½ postrostral carapace length. Carapace with gastric and intestinal tubercles medially or else smooth 57

57(56) Carapace completely smooth except for lateral branchial tubercle. Supraorbital eave produced as a blunt forwardly directed spine
H. irami (Laurie, 1906)
Very small; in Australia known only from C. Jaubert (NW); Ceylon; sublittoral (Laurie 1906: 379, pl. 1 figs. 4, 4a).

— Carapace with at least a trace of 1 or 2 medial tubercles in gastric, cardiac and intestinal regions. Supraorbital eave acute anteriorly but not forwardly produced 58

58(57) Rostral spines curved slightly outwards distally. Branchial regions with 2-3 small tubercles laterally including that at widest part of carapace . . . . *H. convexus* Miers, 1884
Small; NE, N, NW; Indian O., Indo-Malaya; sublittoral to shallow offshore (Miers 1884: 196, pl. XVIII figs. B, b).

— Rostral spines curved slightly inwards distally. Branchial regions completely smooth laterally except for small spine at widest part of carapace . . . . *H. espinosus* Borradaile, 1903
Small; in Australia known only from C. Jaubert (NW); Maldive Archipelago; sublittoral (Borradaile 1903: 688, pl. XLVII figs. 4a-d).

59(44) Carapace armed with several prominent tubercles and generally a few spines. Supraorbital eave and postorbital lobe separated by a narrow fissure. Ambulatory legs smooth . . *Doclea* Leach, 1814
Tropical Indo-Pacific, 13: *D. profunda* Rathbun, 1918; small; known only from a single ovigerous female taken in Great Australian Bight, south of Eucla (SW), in 250-450 fms; further distinguished by single cardiac and intestinal spine and single hepatic and branchial marginal spines; narrowly pyriform carapace unusual for this genus (Rathbun 1918: 16 pl. VII figs. 1, 2) .

— Carapace unevenly and indistinctly tuberculate, lacking spines. Supraorbital eave completely fused with postorbital lobe. Ambulatory legs armed with a few spines and tubercles . . . .
Perinia Dana, 1851
Widespread Indo-West Pacific, monotypic: *P. tumida* Dana, 1851 (= *Parathoe rotundata* Miers, 1879); very small; NE; littoral; further distinguished by short, broad, apically inwardly curved rostral spines and denticulate dactyli (Miers 1879b: 16, pl. V fig. 2, 2a; Sakai 1938: 294, fig. 40).

60(43) Supraorbital eave well expanded posterolaterally, separated from postorbital lobe by an extremely narrow fissure. Rostrum bifid for distal half only. Carapace armed with a few slender spines Ambulatory legs long, the first at least twice carapace length, slender, smooth . . . . *Austrolibinia*, n. gen.
India, New Guinea, Australia, 2: *A. gracilipes* (Miers, 1879) n. comb.; small; NE, N, NW; New Guinea; shallow offshore; further distinguished by 2 medial gastric and 1 medial cardiac spine, a broad, acute intestinal lobe and 2 dorsal branchial spines (Miers 1879b: 7, pl. IV figs. 4, 4a).

— Supraorbital eave weakly expanded posterolaterally, separated from postorbital lobe by a wide U sinus. Rostrum less than 1/6 postrostral carapace length, bifid for at least distal 2/3. Carapace armed with numerous, short, very coarse spines. Ambulatory legs little longer than carapace, stout, spinous . . . .
Hoplophrys Henderson, 1893
Tropical Indo-West Pacific; see Alcock (1895), Sakai (1932), Buitendijk (1939); 2: *H. ogilbyi* McCulloch, 1908; small; in Australia known only from Moreton B. (NE); Indo-Malaya (Moluccas, Ceram), ?Japan; sublittoral; further distinguished by simple spine at lateral branchial angle (McCulloch 1908: 51, pl. xii fig. 2, 2a).

61(1) Basal antennal article not specially expanded to form a floor to the orbit, which is formed by a supraorbital eave, a postorbital lobe and an intercalated spine between the two . . . .
Subfamily MAJINAE 62

— Basal antennal article expanded to form a floor to the orbit which is formed above by eave and postorbital lobe; intercalated spine present or absent . . . . . Subfamily MITHRACINAE 81

62(61) Postorbital lobe a simple acute spine more or less isolated from orbit and affording no concealment to cornea of eyestalk 63

— Postorbital lobe cupped, close to orbit and affording some concealment to cornea of retracted eyestalk 66

63(62) Rostral spines shorter than width at base, fused for basal 1/3. Postorbital spine no longer than intercalated spine. Basal antennal article slightly narrowed anteriorly, lateral margin notched distally. Carapace very weakly tuberculate . . . .
Paramithrax H. Milne Edwards, 1834
Restricted to Australia, monotypic: *P. barbicornis* (Latreille, 1825) (= *Gonatorhynchus tumidus* Haswell, 1880); medium; SW, S, SE; littoral to shallow offshore; further distinguished by two small marginal branchial tubercles (Griffin 1963b: 137, figs. 7-14).

— Rostral spines longer than their width at base, distinct from base. Postorbital spine distinctly longer than intercalated spine. Basal antennal article of even width throughout, or produced into a lobe anterolaterally, not notched laterally or narrowed distally. Carapace spinous or densely tuberculate 64

64(63) Chelipeds in adult male robust, merus tuberculate or spinous, carpus with a dorsal and lateral longitudinal ridge. Eyestalks not especially slender and hardly reaching postorbital spine . . .
Notomithrax Griffin, 1963 ... 65
South Pacific to Juan Fernandez; review of species in Griffin (1963a); 5.

— Chelipeds in both sexes slender and unarmed, carpus sub-cylindrical, lacking ridges. Eyestalks long and slender, reaching postorbital spine . . . . *Maja* Lamarck, 1801
Tropical Indo-West Pacific, E. Atlantic & Mediterranean, 15: *M. miersii* Walker, 1890; large; in Australia known only from C. Jaubert (NW); Singapore, Japan; sublittoral to shallow offshore; further distinguished by 2 medial and 5 marginal spines (Sakai 1938: 298, pl. XXXVIII fig. 2).

65(64) Carapace with both spines and tubercles dorsally. Hepatic margin with two spines, branchial margin with seven spines . . . . . *N. minor* (Filhol, 1885)
(= *Paramithrax peronii;* Haswell, 1882); large; SE, NE; New Zealand; sublittoral to lower shelf; further distinguished by spines of branchial margin being alternately large and small; usually thickly covered by algae, hydroids and sponges (Rathbun 1918: 18, pl. VIII).

— Carapace with numerous low tubercles dorsally. Hepatic and branchial margins each with three spines . . . *N. ursus* (Herbst, 1788)
(= *Paramithrax latreillei* Miers, 1876); large; SE; New Zealand; littoral; hepatic and branchial marginal spines decrease in size posteriorly, body thickly hirsute (Griffin in press, b, fig.).

66(62) Postorbital lobe sometimes with spines or tubercles on posterior edge but not on anterior upper edge 67

— Postorbital lobe with a prominent accessory spine on upper anterior edge near base 78

67(66) Supraorbital eave seldom with a preorbital spine. Rostral spines straight but divergent, seldom more than 1/6 postrostral portion of carapace in length. Carapace densely tuberculate, margins spinous. Chelipeds with merus and carpus variously tuberculate . . *Leptomithrax* Miers, 1876 68
Australasia, Indo-Malaya, Japan; review of Australian and New Zealand species in Griffin (in press, b); 16; all Australian species except *L. tuberculatus* restricted to Australia.

— Supraorbital eave with a prominent preorbital lobe directed outwards or upwards. Rostral spines straight and divergent, or, more usually, outwardly curved distally, in length at least ¼ postrostral portion of carapace. Carapace with a few scattered long or short spines or lamellae, otherwise smooth. Chelipeds with merus and carpus smooth or with well-developed longitudinal crests . . . . *Chlorinoides* Haswell, 1880 73
Indo-West Pacific; reviewed in detail in Griffin in press, a); 12.

68(67) Intercalated spine not nearly reaching tip of antorbital spine, almost excluded from outer rim of supraorbital margin by distal approximation of antorbital spine and postorbital lobe. Ambulatory legs hardly longer than carapace 69

— Intercalated spine reaching to tip of antorbital spine, not excluded from rim of supraorbital margin. Ambulatory legs at least 1½ times carapace length 71

69(68) Sternum and abdomen smooth in adults and juveniles of both sexes. Carapace weakly tuberculate. Two marginal branchial spines . . . . *L. parvispinosus* (Ward, 1933)
Medium; SE, NE; littoral; orbit becomes slightly more open in larger specimens (Ward 1933: 392, pl. XXIII fig. 4).

— Sternum or abdomen, or both, excavated as rimmed pits in adult males and juveniles. Carapace strongly tuberculate. Three or four marginal branchial spines 70

70(69) Postorbital lobe acuminate. Four marginal branchial spines . . . *L. tuberculatus* (Whitelegge, 1900)
Medium to large; SE; New Zealand, Kermadecs; shallow offshore to lower shelf; Australian forms with short marginal and long dorsal spines (Whitelegge 1900: 146, pl. XXXIV figs. 1, 2).

— Postorbital lobe truncate distally. Three marginal branchial spines *L. sternocostulatus* (H. Milne Edwards, 1851)
Medium to large; S, SE, NE, NW; shallow offshore; further distinguished by sternal excavations being wholly segmental (Hale 1927: 137, fig. 137).

71(68) Carapace narrowly pyriform, width no more than $\frac{3}{5}$ postrostral length. Postorbital lobe distally slender with a single small spinule close to tip and numerous small tubercles around base. First ambulatory leg twice carapace length . . . . . *L. globifer* Rathbun, 1918
Large to very large; SW; lower shelf and slope to 120 fms. (Rathbun 1918: 23, pls. X, XI).

— Carapace broadly pyriform, at least in adult, width at least 2/3 postrostral length. Postorbital lobe subtriangular, distal portion not especially slender, a prominent spine or tubercle close to tip and another about halfway along posterior edge. First ambulatory leg no more than $1\frac{1}{2}$ times carapace length 72

72(71) Mid-dorsal regions of carapace thickly covered by both spines and tubercles. Ambulatory meri with a blunt terminal dorsal lobe . . . . . *L. gaimardii* (H. Milne Edwards, 1834) (= *L. australiensis* Miers, 1876; *L. spinulosus* Haswell, 1880); very large; SW, S, SE; sublittoral to slope down to 450 fms; postorbital lobe with sharp spinules in juvenile and blunt tubercles in adult (Hale 1927: 135, fig. 135: Griffin 1963b: 133, figs. 1-6, pls. 6, 7).

— Mid-dorsal regions of carapace smooth except for a few short, prominent spines. Ambulatory meri with a prominent sharp terminal dorsal spine . . . . *L. waitei* (Whitelegge, 1900). Very large; SE; shallow offshore to lower shelf; postorbital lobe with sharp accessory spines in juveniles and adults (Whitelegge 1900: 143, pl. XXXIII).

73(67) Preorbital lobe vertically directed upwards from base. Carapace with a few long spines but no lamellae. Rostral spines with a small spinule on dorsal surface near tip . . . . . *C. tenuirostris* Haswell, 1880
Medium; restricted to Australia; NE, N; shallow offshore (Griffin in press, a, fig.).

— Preorbital lobe outwardly directed, at least basally. Carapace with a few spines and some lamellae, particularly around margins and above orbit. Rostral spines without a spinule on dorsal surface 74

74(73) Rostral spines straight, divergent, distal width less than twice basal width. Branchial margins with three spines and, anteriorly, a small lamella. Ambulatory legs with numerous prominent tubercles dorsally arranged in rows . . . . . . *C. goldsboroughi* Rathbun, 1906
Medium; in Australia known from 2 specimens taken off N.S.W. coast in 70-120 fms; Hawaii (Rathbun 1906: 881, pl. XIV fig. 7).

— Rostral spines weakly or strongly outwardly curved, very divergent, distal width at least $2\frac{1}{2}$ times basal width. Branchial margins with two spines posteriorly. Ambulatory legs smooth or minutely spinous 75

75(74) Antorbital lobe a narrow, flattened, distally rounded lamella, preorbital lobe much wider and somewhat longer. Rostral spines weakly curved 76

— Antorbital and preorbital lobes subequal, acuminate. Rostral spines very strongly curved outwards distally 77

76(75) Preorbital lobe simple, acuminate. Rostral spines unarmed. Posterior intestinal margin with a short, cylindrical spine . . . . *C. albanyensis* (Ward, 1933)
Medium; restricted to Australia, NE; sublittoral to shallow offshore (Ward 1933: 391, pl. XXIII fig. 3).

— Preorbital lobe wide distally, truncate or bifid. Rostral spines armed with several strong spines medially. Posterior intestinal margin with a wide, flattened lamella . . . . . *C. spatulifer* (Haswell, 1882)
(= *Acanthophrys aculeatus* A. Milne Edwards, 1865); medium; restricted to Australia, SW, S, SE; sublittoral to slope down to 250 fms (Hale 1927: 137, fig. 138).

77(75) Preorbital spine simple. A single cardiac spine. Intestinal region with two medial spines . . *C. aculeatus* (H. Milne Edwards, 1834)
(= *Acanthophrys aculeatus* var. *armatus* Miers, 1884); large; NE, N, NW; Indian O., Japan; sublittoral to lower shelf (Miers 1884: 193, pl. XVIII, fig. A).

— Preorbital lobe divided into two distinct spines. Cardiac region with a pair of widely divergent, outwardly curved spines. Intestinal region with a single spine . . . . . . *C. longispinus* (de Haan, 1839)
(= *Paramithrax coppingeri* Haswell, 1880); large; SE, NE, NW; widespread Indo-West Pacific; shallow offshore (Sakai 1965: 87, pl. 40 fig. 1).

78(66) Carapace suborbicular. Rostrum exceedingly short, 1/8-1/20 postrostral carapace length, unarmed . . . *Cyclax* Dana, 1851 79
Widespread Indo-Pacific; detailed account in Forest & Guinot (1961); 2.

— Carapace pyriform. Rostrum of moderate length, more than 1/5 postrostral carapace length, bearing one or two spines or tubercles laterally near base . . . *Schizophrys* White, 1847 80
Widespread Indo-West Pacific; 2.

79(78) Intercalated spine distally with three subequal spinules. Basal antennal article with a strong accessory spine between anterolateral and anteromedial spines. Marginal spines of carapace granular almost to tip . . . *C. suborbicularis* (Stimpson, 1858)
(= *Cyclomaia margaritata* A. Milne Edwards, 1872); SW, NW; Seychelles to Tahiti; littoral (Forest & Guinot 1961: 15, figs. 5, 6, 10; pl. VI figs. 1, 2).

— Intercalated spine triangular, granulate basally only. Basal antennal article lacking an accessory spine between main anterior spines. Marginal spines of carapace granular only at their bases . . . *C. spinicinctus* Heller, 1861
Medium; SW, N, NE; E. Africa to Samoa; littoral (Forest & Guinot 1961: 15, figs. 7, 8, 11; pl. VI, fig. 3).

80(78) Rostrum with a single lateral spine. Surface of carapace bearing a few groups of prominent tubercles, especially posteriorly and several spines . . . *S. aspera* (H. Milne Edwards, 1834)
Large; S, NE, N, NW, SW; widespread Indo-West Pacific; littoral (Hale 1927: 134, fig. 139). Figured here pl. xvi, figs. a, b.

— Rostrum with two lateral spines or tubercles. Surface of carapace densely covered by low tubercles dorsally . . . . . *S. dama* (Herbst, 1804)
Large; SW, NW; Indo-Malaya; littoral (Yaldwyn, 1964, fig.).

81(61) Intercalated spine present 82

— Intercalated spine absent (possibly present in *Paranaxia*) 88

82(81) Rostrum weakly deflexed, of two slender spines distinct from base . . . . *Entomonyx* Miers, 1884
Indian O., Japan; monotypic: *E. spinosus* Miers, 1884 (= *Acanthophrys spinosus;* Balss, 1929); small; in Australia known only from Dampier I. (NW); shallow offshore and lower shelf; further distinguished by two marginal branchial spines and densely tuberculate chelipeds (Miers 1884:526, pl. XLVII fig. B; Sakai 1965: 88, pl. 40 fig. 2).

— Rostrum generally steeply deflexed, broad, lamellar, of two spines fused for at least basal third . . . . .
Micippa Leach, 1817 83
Tropical Indo-Pacific; see Miers (1885), Sakai (1938), Buitendijk (1939); 8.

83(82) Eyestalks projecting laterally well beyond postorbital lobe. Rostrum of two distally distinct, truncate lobes . . . . .
M. tuberculosa (H. Milne Edwards, 1834)
(= *Micippa parvirostris* Miers, 1879); small; restricted to Australia, S, SE; littoral; further distinguished by 4 large marginal branchial spines and broad antennal flagellum (Hale 1927: 140, fig. 142).

— Eyestalks reaching only to postorbital lobe. Rostrum of two acute spines, or distally notched 84

84(83) Rostrum terminating in two strong submedial lobes flanked by a short, broad, recurved spine. Carapace strongly tuberculate and lacking spines dorsally 85

— Rostrum distally bifid or notched, without lateral spines. Carapace smooth or granular with a few tubercles or strongly tuberculate and spinous 86

85(84) Orbit open below, a wide hiatus between smooth basal antennal article and postorbital lobe. Anterolateral borders of carapace with 8-10 spines, anterior spines broad, posterior spines acuminate
M. platipes Rűppell, 1830
(= *M. spatulifrons* A. Milne Edwards, 1872); small to medium; NE; widespread Indo-West Pacific; littoral and sublittoral (Sakai 1938: 316, fig. 46; pl. XXXII fig. 2, pl. xxxviii fig. 4; Buitendijk 1939: 254, text-fig. 22, pl. X figs. 2, 4).

— Orbit closed below, strongly tuberculate basal antennal article in broad contact with postorbital lobe. Anterolateral borders with 3-6 acuminate spines or spinules . . . . .
M. philyra (Herbst, 1803)
(= *M. superciliosa* Haswell, 1880; *Paramicippa asperimanus* Miers, 1884; *M. mascarenica* var. *nodulifera* Baker, 1905); medium; SW, NW, N, S; widespread Indo-West Pacific; littoral and sublittoral (Haswell 1880a: 446, pl. 26 figs. 2, 2a; Buitendijk 1939: 253, text-fig. 21, pl. X figs. 1, 3; Sakai 1965: 90, pl. 42 fig. 1).

86(84) Rostrum of two, outwardly curved, sharply pointed spines, distinct for distal half . . . . *M. thalia* (Herbst, 1803)
(= *M. inermis* Haswell, 1880); SW, N, NE; widespread Indo-West Pacific; medium; sublittoral to shallow offshore; further distinguished by 2 medial gastric, 2 submedial cardiac, 1 dorsal branchial and 9 marginal branchial spines (Haswell 1880a; 445 pl. 26 figs. 3, 3a; Sakai 1965: 90, pl. 42 fig. 3).

— Rostral spines fused throughout their length 87

87(86) Carapace minutely granular dorsally with a few tubercles, anterolateral margins with about 3 small spinules. Merus of cheliped dorsally carinate; ambulatory legs tuberculate . . . . . .
M. curtispina Haswell, 1880
Small; NE, N; Singapore; sublittoral; further distinguished by basally vertically deflexed and apically inflexed rostrum (Haswell 1880a: 446, pl. 25 figs. 1, 1a).

— Carapace strongly tuberculate and spinous, anterolateral margins with about 9 prominent spines of various sizes. Merus of chelipeds smooth; ambulatory meri smooth except for a terminal dorsal spine . . . . *M. spinosa* (Stimpson, 1857) (= *Paramicippa affinis* Miers, 1879); medium; restricted to Australia, S, SE; sublittoral and shallow offshore (Hale 1927: 140, fig. 143).

88(81) Supraorbital eave separated from postorbital lobe by a wide fissure, not expanded anteriorly into a preorbital spine or lobe. Rostral spines short, broad . . . . . *Tumulosternum* McCulloch, 1913
Restricted to Australia; monotypic: *T. longimanus* (Haswell, 1880); medium; SE; littoral (Haswell 1880a: 444, pl. XXVI; McCulloch 1913: 334, fig. 45).

— Supraorbital eave separated from postorbital lobe by a very narrow fissure or completely unexpanded posterolaterally, armed with a prominent preorbital spine or lobe. Rostral spines moderately to very long 89

89(88) Rostrum of two distinct, subparallel spines, each apically bifid. Basal antennal article narrowed anteriorly. Carapace weakly tuberculate. Ambulatory legs smooth . . *Paranaxia* Rathbun, 1924
Restricted to Australia; monotypic: *P. serpulifera* (Guérin, 1829); very large; SW, NW, N; sublittoral to shallow offshore Rathbun 1924: 7, Montgomery 1931:417). Figured here, pl. xvii, fig. a.

— Rostrum of two spines, contiguous throughout their length or at most only apically divergent. Basal antennal article with anterolateral angle forwardly produced. Carapace with groups of distinct or confluent tubercles dorsally. Ambulatory legs tuberculate . . . . . . *Tiarinia* Dana, 1851 90
Tropical Indo-West Pacific; see Stimpson (1907), Sakai (1938), Buitendijk (1939); 6.

90(89) Rostrum with two or three lateral spines close to base. Carapace bearing numerous coarse tubercles dorsally . . . . .
T. angusta Dana, 1851
(= *T. spinosirostris* Haswell, 1882); medium; NE, N; Indo-Malaya, Japan; littoral; further distinguished by 3 small, curved, marginal branchial spines (Sakai 1936: 160, fig. 4).

— Rostrum unarmed. Carapace smooth, uneven, or with distant tubercles 91

91(90) Rostrum moderately long, about 1/3 postrostral portion of carapace
T. elegans Haswell, 1882
Medium; known only from off Broughton I., Pt. Stephens (SE) in 25 fms; further distinguished by 2-3 conical submarginal branchial tubercles (Haswell 1882c: 29). Figured here, pl. xvii, fig. b.

— Rostrum short, less than 1/5 postrostral portion of carapace 92

92(91) Carapace with distinct erect tubercles and granules dorsally, branchial region with six obtuse tubercles laterally . . . *T. cornigera* (Latreille, 1825) (= *T. mammillata* Haswell, 1880); medium to large; NW; Indian O., Indo-Malaya, Japan; littoral; carapace very wide—width equal to postrostral length (Sakai 1965: 91, pl. 42 fig. 2; Buitendijk 1939: pl. XI fig. 1).

— Carapace with confluent depressed tubercles or smooth dorsally, branchial regions with five, or fewer, acute tubercles laterally 93

93(92) Branchial regions with five large tubercles laterally. Preorbital spine quite stout. Seventh abdominal segment in male wider than long . . . . . *T. gracilis* Dana, 1852 (= ?*T. depressa* Stimpson, 1857); medium; SE, NE; Indo-Malaya, Japan; littoral; further distinguished by 3 large, subequal, blunt tubercles on posterior margin (Stimpson 1907: 12, pl. III fig. 2; Sakai 1938: 321, fig. 49; Buitendijk 1939: 259, text-fig. 26, pl. XI fig. 2).

— Branchial regions with a single sharp spine at widest part of carapace laterally. Preorbital spine very slender. Seventh abdominal segment in male much longer than wide . . . . *T. tiarata* (Adams & White, 1848) Small; N. Guinea; West Pacific; sublittoral; further distinguished by completely straight rostral spines (Sakai 1938: 322, pl. XXXVIII fig. 7).

VII. ZOOGEOGRAPHY

Two features of the Australian majid fauna stand out—(1) the relatively large proportion of species (31%) which have been recorded only once from a single locality in Australia; and (2) the very clear partitioning of the fauna into tropical and temperate components.

Of the poorly known species, 12 are not known outside Australia whilst 16 are very widely distributed species known from several parts of the Indo-West Pacific. Ten of the species were recorded by Rathbun, either from the "Endeavour" collections or from near Cape Jaubert (Rathbun 1918, 1924), two were recorded by Whitelegge (1900) and two by Baker (1905, 1906). Fewer species have been recorded from Western Australia than from eastern coasts.

The geographical boundaries between the tropical and temperate faunas are in the form of very broad transition areas (containing a mixture of tropical and temperate species) extending from Shark Bay to Fremantle on the west coast and from about Mast Head Island to Cape Howe on the east. Slightly narrower transition areas between south-eastern and south-western provinces on the one hand and between north-eastern and north-western provinces on the other, appear to exist just west of Kangaroo Island in the south and around Torres Strait in the north. The four faunal provinces which emerge here are in general agreement with the findings of workers on other groups of marine animals (see Bennett & Pope 1953). Two points should be mentioned here—(1) the Spencer Gulf area of South Australia shows a very close affinity with the rest of south-eastern Australia but possesses five species which are tropical and not otherwise known from temperate latitudes (*Oncinopus aranea, Anacinetops stimpsoni, Huenia proteus, Schizophrys aspera* and *Micippa philyra*); (2) the Torres Strait fauna is a mixture of species otherwise known from north-eastern and to a lesser extent north-western, Australia with very few species confined to the region.

The tropical fauna is clearly part of that of the Indo-West Pacific region and possesses few species restricted to Australia. The first feature is borne


Schizophrys aspera
Oncinopus aranea
Hyastenus diacanthus
Paranaxia serpulifera
Leptomithrax sternocostulatus
Chlorinoides spatulifer
Achaeus fissifrons
Naxia aurita

out most strikingly by the fact that a larger proportion of it is shared with other Indo-West Pacific areas than with temperate Australian provinces. Thus, of the north-eastern species only 18% extend southward compared with 50% which are shared with the Indian Ocean, 47% with Japan and 36% with Indo-Malaya. Similarly, for the north-western fauna, 28% extend southward whereas 72% are shared with the Indian Ocean, 48% with Japan and 60% with Indo-Malaya. However, the proportion of species which are distributed throughout the Australian tropical area is not very high. For example 42% of the species found in north-eastern Australia are shared with north-western Australia and the proportion falls to 29% if Torres Strait is excluded. Indian Ocean species are represented to approximately equal extents (about 60%) in both the north east and north west but the Japanese species are definitely best represented in the north east (also about 60%). Widespread Indo-West Pacific species which are also widely distributed in the Australian tropics include *Oncinopus aranea, Menaethius monoceros,* several species of *Hyastenus, Schizophrys aspera,* two species of *Chlorinoides,* three of *Micippa* and two of *Tiarinia.*

The low degree of restriction in the tropical fauna is evidenced by fewer than 30% of the species in either of the tropical provinces which are not found outside Australia and about 30% which are restricted to any one province. Restricted Australian species found in the tropics include species of *Zewa, Hyastenus minimus, Phalangipus australiensis* and two species of *Chlorinoides.*

The temperate provinces contain fewer species and overall there is a much greater restriction of these species both to Australia and to particular provinces. Thus, only nine species are found in both south-western and south-eastern Australia out of a total of 34 south-eastern and 20 south-western species; 40% of the south-eastern and 50% of the south-western species are not known outside Australia. Eight species appear to be widespread temperate forms (two species of *Naxia, Ephippias endeavouri, Paratymolus latipes,* two species of *Leptomithrax* and *Chlorinoides spatulifer*). The relationships of the temperate species are either with tropical Australia (e.g., species of *Paratymolus, Zewa, Huenia, Xenocarcinus, Hyastenus, Chlorinoides* and *Micippa*) or with the Indo-West Pacific (e.g. species of *Achaeopsis, Platymaia, Cyrtomaia, Pugettia, Doclea, Eurynome* and *Leptomithrax*). The relationships with temperate regions outside Australia are slight. Only one species which does not have a tropical distribution, *Achaeopsis thomsoni,* is shared with South Africa. Five species, all of which are found in south-eastern Australia, are shared with New Zealand. Of the nine genera shared with New Zealand, seven are more or less widespread in the Indo-West Pacific. The strong restricted element in the Australian temperate fauna is exemplified by species of *Naxia, Ephippias endeavouri, Paramithrax barbicornis* and *Tumulosternum longimanus.* Of the 37 species restricted to Australia, 69% are temperate.

If only species which penetrate the transition zones between tropical and temperate regions are considered, there is indeed only a very slight partitioning of the fauna into eastern and western elements. Such eastern species probably number no more than six (e.g. *Naxia tumida* and *Notomithrax minor*) and western ones no more than five (e.g., *Paranaxia serpulifera* and *Schizophrys dama*). If more stenothermal species are considered a division between eastern and western regions is quite clear.

Distant relationships of the fauna are shown, at the specific level, by nine species shared with South Africa, 10 with the Red Sea and eight with Hawaii; one species, *Achaeopsis thomsoni,* is also found in the Atlantic. The vast majority of these widespread species are represented in the tropical fauna of Australia.

Figure 3. Known Australian distribution of eight species of majid spider crab. (Each circle represents a single recorded locality).

The zoogeographical features shown by the species are strongly emphasised at the generic level. Thus 58% of the 43 genera have widespread tropical Indo-West Pacific representation. A further 16%, also represented in the Indo-West Pacific, have wider relationships, four genera (*Achaeus, Achaeopsis, Eurynome* and *Maja*) being found in the Atlantic and three (*Pugettia, Herbstia* and *Rochinia*) in the eastern Pacific. An additional 7% (three genera—*Picroceros, Sargassocarcinus* and *Leptomithrax*) are western Pacific only. Two genera, *Naxia* and *Notomithrax,* both temperate, are mainly Australasian. Five genera (12%) (*Anacinetops, Ephippias, Paramithrax, Tumulosternum* and *Paranaxia*) are restricted to Australia; all are monotypic and part of the temperate fauna. Evidence of bipolarity or antitropicality in the Australian majid fauna is, I think, difficult to discern, although the genera *Cyrtomaia, Zewa, Xenocarcinus, Pugettia, Sargassocarcinus, Eurynome, Rochinia, Hoplophrys* and *Leptomithrax* may provide some evidence of such distribution patterns.

Of the other Australian crabs the two best known families are the Portunidae (Stephenson 1962) and the Grapsidae (Tesch 1918, Banerjee 1960, Campbell and Griffin, 1966). In both these families the existence of a few more or less widespread temperate species, such as *Leptograpsus variegatus* (Fabricius), *Plagusia capensis* de Haan, *Macropipus corrugatus* (Pennant), *Ovalipes punctatus* (de Haan) (last two also bipolar) and *Nectocarcinus integrifrons* (Latreille), should not be allowed to obscure the fact that the temperate representatives as a whole relate themselves most closely to the tropical faunas. These two families are proportionally less represented in temperate regions of Australia than are the Majidae.

In conclusion it can be stated that the features shown by the Australian Majidae are those shown by other Australian marine animals (see Ekman 1953). This is particularly true of the partitioning into a tropical fauna with tropical Indo-West Pacific relationships and a temperate fauna related to the tropical fauna of Australia rather than to temperate faunas outside Australia. There is also agreement in the apparent position of transition areas and the geographical extent of the faunal provinces; only the Peronian province (central eastern Australia) (see Bennett and Pope 1953) may be of doubtful validity for the majids.

VIII. ACKNOWLEDGMENTS

I wish to thank first the Trustees and Director (Dr. J. W. Evans) of the Australian Museum, Sydney, for providing a grant which allowed me to examine much of the Museum's collections of spider crabs in January 1963. I wish similarly to acknowledge the financing of those studies by a Research Grant from the University of Tasmania. I am grateful also to Drs. Danièlle Guinot and J. Forest (Muséum National d'Histoire Naturelle) and T. Sakai (Yokohama National University) for sending literature, Drs. Isabella Gordon (British Museum (Natural History)) and R. B. Manning (U.S. National Museum) for providing photographs of type material in their care, Messrs. Frank A. McNeill, Melbourne Ward (Australian Museum) and Bruce Campbell (Queensland Museum) for discussion and aid with literature, and Messrs. Athol Beswick and Anthony Healy for photography. The manuscript was read by Drs. John S. Garth (Allan Hancock Foundation), R. W. George (Western Australian Museum) and J. C. Yaldwyn (Australian Museum), all of whom provided most helpful comments for which I am very grateful; this review has also been considerably aided by Dr. Yaldwyn's kindness in forwarding material and literature.

IX. REFERENCES

Adams, A. and White, A. (1848). Crustacea. *In* A. Adams (ed.), Zoology of the Voyage of H.M.S. "Samarang" under the command of Captain Sir Edward Belcher, during the years 1843-46. London. Pp. viii, 66, 13 pls.

Alcock, A. W. (1895). Materials for a Carcinological Fauna of India. 1. The Brachyura Oxyrhyncha. *J. Asiat. Soc. Beng.* 64: 157-291 pls. 3-5.

Alcock, A. W. and Anderson, A. R. (1897). Illustrations of the Zoology of H.M. Indian Marine Survey Steamer "Investigator." Crustacea Decapoda. Pls. 33-35. Calcutta.

Baker, H. W. (1905). Notes on South Australian Decapod Crustacea.. Part 2. *Trans. roy. Soc. S. Aust.* 29: 116-131, pls. XXI-XXIV.

——— (1906). Notes on South Australian Decapod Crustacea. Part 4. *Trans. roy. Soc. S. Aust.* 30: 104-117, pls. I-III.

Balss, H. (1929). Decapoden des Roten Meeres. IV. Oxyrhyncha und Schlussbetrachtungen. *Denkschr. Akad. Wiss. Wein. Math-nat. Kl.* 102: 1-30, text-figs. 1-9, pl. 1.

——— (1935). Brachyura of the Hamburg Museum Expedition to Southwestern Australia, 1905. *J. roy. Soc. W. Aust.* 21: 113-151, figs. 1-5, pl. 13.

——— (1957). Abteilung Brachyura, Borradaile, 1907. *In* H. G. Bronns, *Klassen und Ordnungen des Tierreichs* 5 (1) 7, Decapoda 12: 1505-1672, figs. 1131-1199.

Banerjee, S. K. (1960). Biological Results of the Snellius Expedition. XVIII. The genera *Grapsus, Geograpsus* and *Metopograpsus* (Crustacea, Brachyura). *Temminckia* 10: 132-199, text-figs. 1-6).

Barnard, K. H. (1950). Descriptive Catalogue of South African Decapod Crustacea (Crabs and Shrimps). *Ann. S. Afr. Mus.* 38: 1-837, figs. 1-154.

Bennett, I. and Pope E. C. (1953). Intertidal Zonation of the Exposed Rocky Shores of Victoria, together with a rearrangement of the Biogeographical Provinces of Temperate Australian Shores. *Aust. J. Mar. Freshw. Res.* 4(1): 105-159, figs. 1-5, pls. 1-6.

Borradaile, L. A. (1903). The Spider Crabs (Oxyrhyncha). *In* J. S. Gardiner, *The Fauna and Geography of the Maldive and Laccadive Archipelagos* 2 (10): 681-690, figs. 122-124, pl. XLVII.

Buitendijk, A. M. (1939). Biological Results of the Snellius Expedition. V. The Dromiacea, Oxystomata and Oxyrhyncha of the Snellius Expedition. *Temminckia* 4: 223-276, text-figs. 1-27, pls. VII-XI,

Calman, W. T. (1900). On a Collection of Brachyura from Torres Straits. *Trans. Linn. Soc. Lond.* (*Zool.*) (ser. 2) 8: 1-50, pls. 1-3.

——— (1909). On Decapod Crustacea from Christmas Island, collected by Dr. C. W. Andrews. *Proc. zool. Soc. Lond.* 1909: 703-713, pl. 72.

——— (1913). Note on the Brachyuran Genera *Micippoides* and *Hyastenus*. *Ann. Mag. nat. Hist.* (ser. 8) 11: 312-314.

Campbell, B. M. and Griffin, D. J. G. (1966). The Australian Sesarminae (Crustacea: Brachyura): Genera *Helice, Helograpsus* nov. *Cyclograpsus* and *Paragrapsus*. *Mem. Queensl. Mus.* 14 (5): 127-174, 10 figs., pls. xx-xxiii.

Chhapgar, B. F. (1957). On the marine crabs (Decapoda: Brachyura) of Bombay State. *J. Bombay nat. Hist. Soc.* 54: 399-439, 503-549, 3 figs. 16 pls.

Dana, J. D. (1851). On the Classification of the Maioid Crustacea or Oxyrhyncha. *Amer. J. Sci.* (ser. 2) 11: 425-434.

——— (1852). Crustacea. *In* "U.S. Exploring Expedition during the years 1838-1842 under the command of Charles Wilkes, U.S.N." 13. Philadelphia: C. Sherman. Pp. viii, 1618. Atlas (1855): 27 pp., 96 pls.

Ekman, S. (1953). Zoogeography of the Sea. London: Sidgwick & Jackson. 417 pp., 121 figs.

Forest, J. and Guinot D. (1961). Crustacés Décapodes Brachyoures de Tahiti et des Tuamotu. *In* Expédition française sur les récifs coralliens de la Nouvelle-Calédonie. *Vol. prélim*: i-xi, 1-195, 178 figs. 7 maps, 18 pls.

Fulton, S. W. and Grant, F. E. (1906a). Some little known Victorian Decapod Crustacea, with Descriptions of New Species. No. III *Proc. roy. Soc. Vict.* 19 (1): 5-15, pls. III-V.

——— (1906b). Census of the Victorian Decapod Crustacea. Part 1. Brachyura. *Proc. roy. Soc. Vict.* 19 (1): 16-20.

Garth, J. S. (1958). Brachyura of the Pacific Coast of America: Oxyrhyncha. *Allan Hancock Pacif. Exped.* 21: 1-854, 106 tables, 9 text-figs., 82 pls.

Garth, J. S. and Holthuis, L. B. (1963). *Stenorhynchus* Lamarck, 1818 (Crustacea, Decapoda): Proposed Validation under the Plenary Powers with Designation of *Cancer seticornis* Herbst, 1788, as Type Species. Z.N. (S.) 751. *Bull. zool. Nomencl.* 20(6): 424-428.

Glaessner, M. F. (1960). The Fossil Decapod Crustacea of New Zealand and the Evolution of the Order Decapoda. *N.Z. geol. Surv. paleont. Bull.* 31: 1-63, figs. 1-25, pls. 1-7.

Gordon, I. (1934). Crustacea Brachyura. Résultats Scientifiques du Voyage aux Indes Orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique. *Mem. Mus. roy. Hist. nat. Belg.* Hors. ser., III (15): 1-78, figs. 1-37.

Grant, F. E. (1905). Crustacea dredged off Port Jackson in Deep Water. *Proc. Linn. Soc. N.S.W.* 30 (2): 313-324, pl. x, xi.

Grant, F. E. and McCulloch, A. R. (1906). On a Collection of Crustacea from the Port Curtis District, Queensland. *Proc. Linn. Soc. N.S.W.* 31 (1): 1-53, 4 pls.

Gray, J. E. (1831). Zoological Miscellany, no. 1 (February 1831): 40. London.

Griffin, D. J. G. (1963a). *Notomithrax* gen. nov. and the Status of the Genus *Paramithrax* H. Milne Edwards (Crustacea, Brachyura, Majidae). *Trans. roy. Soc. N.Z. Zool.* 3 (22): 229-237.

——— (1963b). Redescriptions of the Australian majid spider crabs *Leptomithrax gaimardii* (H. Milne Edwards) and *Paramithrax barbicornis* (Latreille). *Rec. Aust. Mus.* 26 (4): 131-143, figs. 1-14, pls. 6, 7.

——— (1964). A Review of the Genus *Eurynome* Leach (Decapoda, Majidae) and a New Species from New Zealand. *Crustaceana* 6 (3): 195-206, figs. 1-11.

——— (1965). A Redescription of the Australian Spider Crab *Eurynome granulosa* Baker (Crustacea, Brachyura, Majidae). *Rec. S. Aust. Mus.* 15 (1): 29-37, 5 figs.

——— (in press, a). The Genus *Chlorinoides* (Crustacea, Brachyura, Majidae). 1. A Redescription of *C. tenuirostris* Haswell and the Status of the Genus *Acanthophrys* A. Milne Edwards. *Rec. Aust. Mus.*

——— (in press, b). The Marine Fauna of New Zealand: Spider Crabs of the Family Majidae (Crustacea, Brachyura). *N.Z. Oceanogr. Inst. Mem.* 35

Griffin, D. J. G. and Yaldwyn, J. C. (1965). A Record of the Majid Brachyuran Genus *Achaeus* from New Zealand, with Notes on the Australian Species. *Trans. roy. Soc. N.Z. Zool.* 6 (4): 33-51, figs. 1-8.

Haan, W. de (1833-1850). Crustacea *In* P. F. von Siebold, "Fauna Japonica." Amsterdam: Muller. Pp. xvii, xxxi, 244, 55 pls.

Hale, H. M. (1924). The Flora and Fauna of the Nuyts Archipelago and the Investigator Group. No. 16. The Crustacea. *Trans. roy. Soc. S. Aust.* 48: 67-73, figs. 1, 2, pl. 1.

——— (1927). The Crustaceans of South Australia. Pt. 1: 1-201, figs. 1-202. Adelaide: Govt. Printer.

Hale, H. M. (1929). Notes on the Fauna of Dirk Hartog Island, Western Australia. No. 4. Crustacea. *Trans. roy. Soc. S. Aust.* 53: 67-70, pl. 5.

Hartnoll, R. G. (1964). Reduction of the gill number in Spider Crabs. *Crustaceana.* 7 (2): 145-148.

Haswell, W. A. (1879). On two new species of the genus *Stenorhynchus. Proc. Linn. Soc. N.S.W.* 3: 408-409.

——— (1880a). On the Australian Brachyura Oxyrhyncha. *Proc. Linn. Soc. N.S.W.* 4: 431-458, pls. 25-27.

——— (1880b). Notes on the Australian Maioid Brachyura. *Ann. Mag. nat. Hist.* (ser. 5) 5: 145-147.

——— (1880c). On two new species of the genus *Paratymolus* Miers from Australia. *Ann. Mag. nat. Hist.* (ser. 5) 5: 302-304, pl. XVI.

——— (1882a). On some new Australian Brachyura. *Proc. Linn. Soc. N.S.W.* 6: 540-551.

——— (1882b). Descriptions of some New Species of Australian Decapoda. *Proc. Linn. Soc. N.S.W.* 6: 750-763.

——— (1882c). Catalogue of the Australian Stalk- and Sessile-eyed Crustacea. Sydney: Australian Museum. Pp. xxiv, 326, 4 pls.

Holthuis, L. B. (1962). Forty-seven genera of Decapoda (Crustacea); Proposed Addition to the Official List. Z.N. (S.) 1499. *Bull. zool. Nomencl.* 19 (4): 232-253.

Laurie, R. D. (1906). Report on the Brachyura collected by Professor Herdman at Ceylon in 1902. *Rep. Pearl. Oyster Fish., Ceylon* 5: 349-432, figs. 1-12, pls. I, II.

McCulloch, A. R. (1908). Studies in Australian Crustacea. No. 1. *Rec. Aust. Mus.* 7: 51-59, pl. xii.

——— (1913). Studies in Australian Crustacea. No. 3. *Rec. Aust. Mus.* 9: 321-353, pls. x, xi.

Macleay, W. S. (1838). Brachyurous Decapod Crustacea. *In* A. Smith (ed.), Illustrations of the Zoology of South Africa. 5. Invertebrata 3: 53-71, pls. 2, 3. London: Smith, Elder and Co.

McNeill, F. A. (1923). Crustacean Camoufleurs. *Aust. Mus. Mag.* 1 (8): 243-6, illus.

——— (1926). The Biology of North-west Islet, Capricorn Group. (J.) Crustacea. *Aust. Zool.* 4 (5): 299-318, text-figs. 1, 2, pl. XLI.

——— (1953). Carcinological Notes. No. 2. *Rec. Aust. Mus.* 23 (3): 89-96, pl. VII.

——— (In prep.) Crustacea Decapoda and Stomatopoda. *Sci. Rep. Great Barrier Reef Exped. 1928-29.*

Man, J. G. de (1888). Bericht über die von Herrn Dr. J. Brock im indischen Archipel gesammelten Decapoden und Stomatopoden. *Arch. Naturgesch.* 53 (1): 215-600, pls. 7-22.

Miers, E. J. (1879a). On a collection of Crustacea made by Capt. H. C. St. John, R.N. in the Corean and Japanese Seas. I. Podophthalmia. *Proc. zool. Soc. Lond.* 1879: 18-61, pls. 1-3.

——— (1879b). Descriptions of New or little known species of Maioid Crustacea (Oxyrhyncha) in the Collections of the British Museum. *Ann. Mag. nat. Hist.* (ser. 5) 4: 1-28, pls. IV, V.

——— (1879c). On the Classification of the Maioid Crustacea or Oxyrhyncha, with a synopsis of the Families, Subfamilies and Genera. *J. Linn. Soc. Lond.* (*Zool.*) 14: 634-673, pls. 12, 13.

——— (1882). On some Crustaceans collected at Mauritius. *Proc. zool. Soc. Lond.* 1882: 339-343, pls. XX.

——— (1884). Crustacea. *In* "Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. "Alert", 1881-2": 178-322, 513-575, pls. XVIII-XXXIV, XLV-LII. London: British Museum (Natural History).

——— (1885). On the species of *Micippa* Leach and *Paramicippa* M. Edw. *Ann. Mag. nat. Hist.* (ser. 5) 15: 1-13, pl. 1.

Miers, E. J. (1886). Report on the Brachyura collected by H.M.S. "Challenger" during the years 1873-1876. *Rep. Voy. Challenger, Zool.* 17(2): 1-362, pls. 1-29. London, Edinburgh and Dublin.

Milne Edwards, A. (1865). Descriptions de quelques Crustacés nouveaux, appartenant a la tribu des Maiens. *Ann. Soc. entom. Fr.* (ser. 4) 5: 133-147, pls. 3-5.

——— (1872). Recherches sur la faune carcinologique de la Nouvelle-Calédonie. *Nouv. Arch. Mus. Hist. nat., Paris.* 8: 229-267, pls. X-XIV.

——— (1873). Descriptions de quelques Crustacés nouveaux ou peu connus provenant du Musée de M. C. Godeffroy. *J. Mus. Godeffroy* 1(4): 253-264, pls. 12, 13.

Milne Edwards, H. (1834). Histoire Naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux. I: i-xxv, 1-468. Atlas. Paris: Lib. Roret.

Montgomery, S. K. (1931). Report on the Crustacea Brachyura of the Percy Sladen Trust Expedition to the Abrolhos Islands under the leadership of Prof. W. J. Dakin in 1913, along with other Crabs from Western Australia. *J. Linn. Soc. Lond.* (*Zool.*) 37: 405-465, 1 fig., pls. 24-30.

Ortmann, A. (1894). Crustaceen. In R. Semon, *Zoologische Forschungsreisen Australien und dem Malayischen Archipel.* 5 (1): 30-80, 3 pls. (*Denkschr. med. naturw. Ges Jena* 8: 1-80.).

Rathbun, M. J. (1892). Catalogue of the Crabs of the family Periceridae in the U.S. National Museum. *Proc. U.S. nat. Mus.* 15: 231-277, pls. 28-40.

——— (1893). Catalogue of the Crabs of the family Maiidae in the U.S. National Museum. *Proc. U.S. nat. Mus.* 16: 63-103, pls. 3-8.

——— (1894). Catalogue of the Crabs of the family Inachidae in the U.S. National Museum. *Proc. U.S. nat. Mus.* 17: 43-75, pl. 1.

——— (1897). A revision of the nomenclature of the Brachyura. *Proc. biol. Soc. Wash.* 11: 153-167.

——— (1906). The Brachyura and Macrura of the Hawaiian Islands. *Bull. U.S. Fish. Comm.* 23 (3): 827-930, text figs. 1-79, pls. 3-25.

——— (1911). The Percy Sladen Trust Expedition to the Indian Ocean in 1905: Marine Brachyura. *Trans. Linn. Soc. Lond.* (*Zool.*) (ser. 2) 14 (2): 191-261, pls. 15-20.

——— (1914). Stalk-eyed Crustaceans collected at the Monte Bello Islands. *Proc. zool. Soc. Lond.* 1914: 653-664, pls. I, II.

——— (1916). Scientific Results of the Philippine Cruise of the Fisheries Steamer "Albatross" 1907-10. No. 34. New Species of Crabs of the Families Inachidae and Parthenopidae. *Proc. U.S. nat. Mus.* 50: 527-559.

——— (1918). Report of the Spider Crabs obtained by the F.I.S. "Endeavour" on the Coasts of Queensland, New South Wales, Victoria, South Australia and Tasmania. *Biol. Res. Endeavour 1909-14* V (1): 1-29, 15 pls.

——— (1924). Results of Dr. E. Mjoberg's Swedish Scientific Expeditions to Australia 1910-1913. 37. Brachyura, Albuneidae and Porcellanidae. *Ark Zool.* 16 (23): 1-33, 1 pl.

——— (1925). The Spider Crabs of America. *Bull. U.S. nat. Mus.* 129: 1-613, 153 figs., 283 pls.

Sakai, T. (1932). Notes on some rare materials of Japanese Oxyrhyncha. *Sci. Rep. Tokyo Bunrika Daig.* (B) 1 (4): 41-59, pls. II, III.

——— (1934). Brachyura from the coast of Kyushu, Japan. *Sci. Rep. Tokyo Bunrika Daig.* (B) 1 (25): 281-330, text-figs. 1-26, pls. XVII, XVIII.

——— (1935). New or rare species of Brachyura, collected by the "Misago" during the zoological survey around the Izu-peninsula. *Sci. Rep. Tokyo Bunrika Daig.* (B) 2 (32): 63-88, text-figs. 1-17, pls. VI-VIII.

Sakai, T. (1936). Report on the Brachyura collected by Mr. F. Hiro at Palao Islands. *Sci. Rep. Tokyo Bunrika Daig.* (B) 2 (37): 155-177, text-figs. 1-7, pls. XII-XIV.

——— (1938). Studies on the Crabs of Japan. III. Brachygnatha, Oxyrhyncha: 193-364, text-figs. 1-55, pls. I-XLI. Tokyo: Yokendo Co.

——— (1965). The Crabs of Sagami Bay collected by His Majesty the Emperor of Japan. Tokyo: Maruzen. Pp. xvi, 1-206, 1-26 (English), 1-92, 27-32 (Japanese), 26 text-figs., 100 pls. (coloured), 1 map.

Sankarankutty, C. (1961). On some crabs (Decapoda-Brachyura) from the Laccadive Archipelago. *J. Mar. biol. Ass. India* 3 (1 & 2): 120-136, figs. 1, 2.

——— (1962). On Decapoda Brachyura from the Andaman and Nicobar Islands. 3. Families: Calappidae, Leucosiidae, Parthenopidae, Maiidae, and Gecarcinidae. *J. Mar. biol. Ass. India* 4 (1): 151-164, figs. 1-23.

Stephensen, K. (1945). The Brachyura of the Iranian Gulf, with an Appendix; The Male Pleopoda of the Brachyura. *Danish sci. Invest. Iran* IV: 57-237, 60 figs.

Stephenson, W. (1962). Evolution and Ecology of Portunid Crabs, with especial reference to Australian Species. *In* G. W. Leeper (ed), "The Evolution of Living Organisms": 311-327, 3 tables. Melbourne: University Press.

Stimpson, W. (1857). Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum Setentrionalem, e Republica Federate missa, C. Ringgold et J. Rodgers Ducibus, observavit et descripsit. III. Crustacea Maioidea. *Proc. Acad. nat. Sci. Philad.* 9 (25): 216-221.

——— (1907). Report on the Crustacea (Brachyura and Anomura) collected by the North Pacific Exploring Expedition. *Smithson. misc. Coll.* 49 (1717): 1-240, pls. i-xxvii.

Tesch, J. J. (1918). The Decapoda Brachyura of The Siboga Expedition. I. Hymenosomidae, Retroplumidae, Ocypodidae, Grapsidae and Gecarcinidae. *Siboga Exped. Monogr.* 39c (82): 1-148, pls. 1-6.

Ward, M. (1933). New genera and species of marine Decapoda Brachyura. *Aust. Zool.* 7: 337-394, pls. 21-23.

——— (1936). Crustacea Brachyura from the coasts of Queensland. *Mem. Queensl. Mus. 11*: 1-13, pls. 1-3.

White, A. (1847). Descriptions of new Crustacea from the Eastern Seas. *Ann. Mag. nat. Hist.* 20: 61-63.

——— (1848). Descriptions of New or little-known Crustacea in the Collections of the British Museum. *Ann. Mag. nat. Hist.* (ser. 2) 1: 221-226.

Whitelegge, T. (1900). Scientific Results of the Trawling Expedition of H.M.C.S. "Thetis", off the coast of New South Wales, in February and March, 1898. Crustacea. Part 1. *Mem. Aust. Mus.* IV: 135-199, pls. 32-35.

Yaldwyn, J. C. (1964). The Ornamental Sea-toad. *Aust. nat. Hist.* XIV (11): 362. (see also: Anon (1965). *Nature* 205 (4977): 1163).

EXPLANATION OF PLATES.

Plate xv (a) *Hyastenus auctus* Rathbun. HOLOTYPE, male, carapace length from photo (including rostral spines in all cases) about 30 mm. Sulu Sea, Philippine Islands, *Albatross Exped.*, U.S. National Museum no. 48214 (Photo: U.S. Nat. Mus.).

(b) *Hyastenus sebae* White. LECTOTYPE (selected on the advice of Dr. I. Gordon), dorsal view, female, carapace length from photo about 11.5 mm. Corregidor, Philippine Islands, British Museum (N.H.) no. 43.6 (Photo: British Museum).

(c) *Hyastenus sebae* White. LECTOTYPE, ventral view (Photo: British Museum).

(d) *Huenia bifurcata* Streets. Male, carapace length 22 mm., setae cleaned from shaft of rostrum only. New South Wales, Australian Museum no. P. 14961 (Photo: Anthony Healy).

(e) *Huenia bifurcata* Streets. Female, carapace length 21 mm, uncleaned. Port Jackson, N.S.W., Aust. Mus. no. G. 5102 (Photo: Anthony Healy).

Plate xvi (a) *Schizophrys aspera* (H. Milne Edwards). Dorsal view, male, carapace length 60.5 mm. Lord Howe Island, W.R.B. Oliver collection, Dominion Museum, Wellington (Photo: Athol Beswick).

(b) *Schizophrys aspera* (H. Milne Edwards). Ventral view of same specimen (Photo: Athol Beswick).

Plate xvii (a) *Paranaxia serpulifera* (Guérin). Male, carapace length 102 mm. Darnley Island, Torres Strait, Aust. Mus. no. G. 2469 (Photo: Anthony Healy).

(b) *Tiarinia elegans* Haswell. HOLOTYPE, male, carapace length 14.5 mm. Off Broughton Island, near Port Stephens, N.S.W., 25 fms. Aust. Mus. no. G. 5140 (Photo: Anthony Healy).

OBSERVATIONS OF SOME AUSTRALIAN FOREST INSECTS

21. *Hesthesis cingulata* (Kirby) (Coleoptera: Cerambycidae), attacking young plants of *Eucalyptus pilularis* Smith.

By K. M Moore

(Text-figs. 1-5)

SYNOPSIS

Some morphological characteristics of larvae, pupae and adults of *Hesthesis cingulata* (Kirby) are described and figured, and damage caused by the larvae to young plants of *E. pilularis* is figured and described. Some biology of the species is given.

INTRODUCTION

To study the effects of various factors on certain tree species, numerous plantings of many species of seedling trees have been made in experimental plots on State Forests in New South Wales. During 1954 a 1½ acre plot of *E. pilularis* tubed stock was established on a marginal blackbutt site on Olney East State Forest (Newcastle Forestry District: Wyong Sub-district).

When observations on the incidence of insect attack on trees within the plot were commenced during March 1965, considerable variability in the growth and health of the plants was evident throughout the plot, and death and debilitation of several plants from 18 inches to 4 feet in height were occurring.

Root and stem portions of 12 damaged plants which contained larvae of various instars of *H. cingulata* were collected and examined during March, May and July 1965, and bred to obtain a correlation of larval, pupal and adult specimens for identification of the insect species concerned.

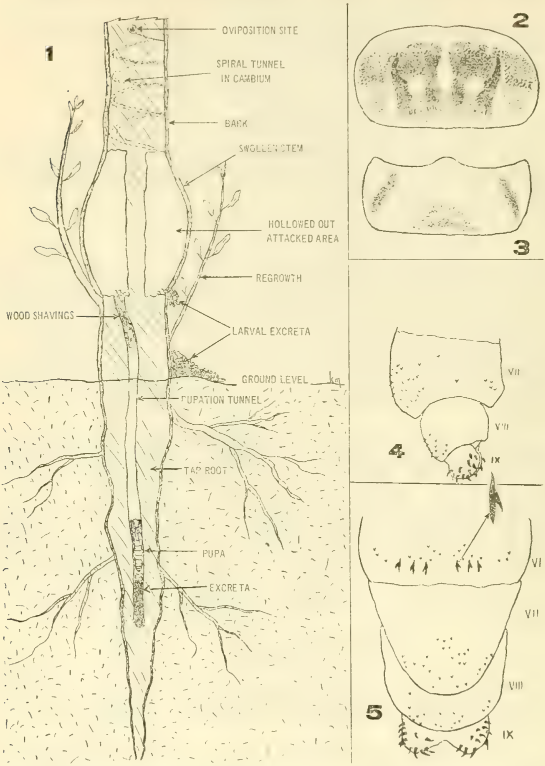
From a detailed examination of larvae, it was not possible to correlate them with any known species, on the information published by Duffy (1965), although it is indicated (p. 133) that larvae of the genus *Hesthesis* damage the root area of plants of *Eucalyptus* and *Leptospermum* spp. Carter (1928) records that *H. cingulata* has been bred from the roots of mallee (*Eucalyptus* spp.)

Larvae of *H. cingulata* cause damage of sufficient severity to be of economic importance to forestry.

BIOLOGY

Oviposition occurs during October to January on the stem of the plant, usually at the junction of a small shoot and the stem, from 2 to 8 inches above ground level. One larva only, occurs in the damaged area of each plant.

The first instar larva commences its gallery in the cambium region, encircling the stem several times in a spiral manner as it works downward toward the root area (Text-fig. 1). From the cambium region the larva then tunnels deeper into the stem, so that no particular pattern or direction of tunnelling may be evident. The outer sapwood region of the stem, at a distance of approximately 4 inches above ground level, is then destroyed by the late instar larva. Slight damage to the basal area of the bark which covers the destroyed area also occurs, and the portion of the stem covering the destroyed area becomes swollen and gall-like in appearance. The bark of the swollen area may contain several small holes through which the excreta are extruded, to collect in a heap on the surface of the ground around the base of the plant stem.



Text-fig. 1. Damage by larva of *Hesthesis cingulata* to stem and root of young plant of *Eucalyptus pilularis*.

Text-fig. 2. Prothorax of last instar larva of *H. cingulata* (Dorsal).

Text-fig. 3. Prothorax of last instar larva of *H. cingulata* (Ventral).

Text-fig. 4. Spines on pupa of *H. cingulata,* on abdominal segments 7 to 9 (Lateral).

Text-fig. 5. Spines on pupa of *H. cingulata,* on abdominal segments 6 to 9 (Dorsal).

Through the centre of the damaged portion of the stem a small section of the wood is retained to form a relatively strong attachment of the stem below the damaged area to that above the damage (Text-fig. 1). Detachment of the upper portion of the plant from the lower portion is thus inhibited while the plant is alive.

From the base of the hollowed out area, a comparatively large oval gallery penetrates the centre of the remainder of the stem above ground level, and the tap root for a variable distance. The depth of penetration is apparently dependent on the diameter and length of the tap root of the attacked plant, and may reach to 5 inches below ground level. A quantity of fine, moist, loose granular excreta is retained in the base of the working within the tap root, and above which the larva reverses its position to pupate.

The extent and effect of damage to plants is variable, so that some plants are killed before the adult insect emerges, or other plants may produce numerous shoots of regrowth from the stem below the hollowed out area, as the larva continues to tunnel in the tap root.

Adults emerge from the plants at above ground level during September to December, and the species is univoltine.

DESCRIPTIONS

Last instar larva:

Creamy white; moderately hairy with short tan coloured hairs; prothorax with a dorsal orange-red area as in Text-fig. 2, and paler orange markings ventrally as in Text-fig. 3.

Pupa:

Creamy white; dorsal, lateral and ventral spines as shown in Text-fig. 4 occur on abdominal segments 7 to 9; large and small dorsal spines as shown in Text-fig. 5 occur on abdominal segments 2 to 6; smaller spines are on segs. 7 & 8. A small group, each of about 5 latero-ventral spines, is on each side of abdom. segs. 4 to 7.

Adults:

The white markings on adult specimens are variable, from 1 to 3 ventral anterior white bands occurring on abdominal segments 1, 2 and 3, although on some specimens these white bands may be absent. Femora, or all of the legs, of male specimens only, may be dark red-brown.

Specimens of larvae, pupae and adults are in the collection of the Forestry Commission of N.S.W.

ACKNOWLEDGEMENTS

The writer is grateful to Messrs. K. G. Campbell and P. Hadlington for their criticism of the manuscript.

REFERENCES

Carter, H. J., 1928.—"Revision of *Hesthesis*, Together With the Description of a New Genus and Species of the Buprestidae." *Proc. Linn. Soc. N.S.W.* 53 (5): 544-550.

Duffy, E. A. J., 1963.—"A Monograph of the Immature Stages of Australian Timber Beetles (Cerambycidae)." British Museum, London.

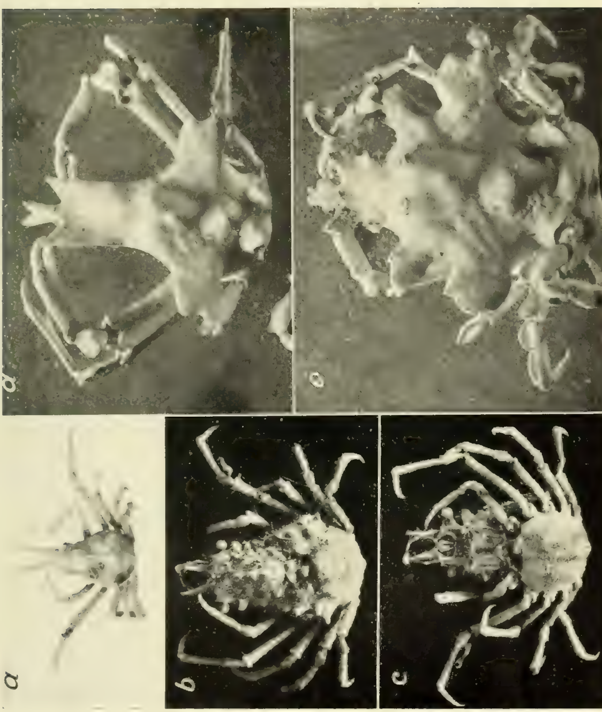
FROG, *HYLA*

SOLE, *STRABOZEBRIAS*

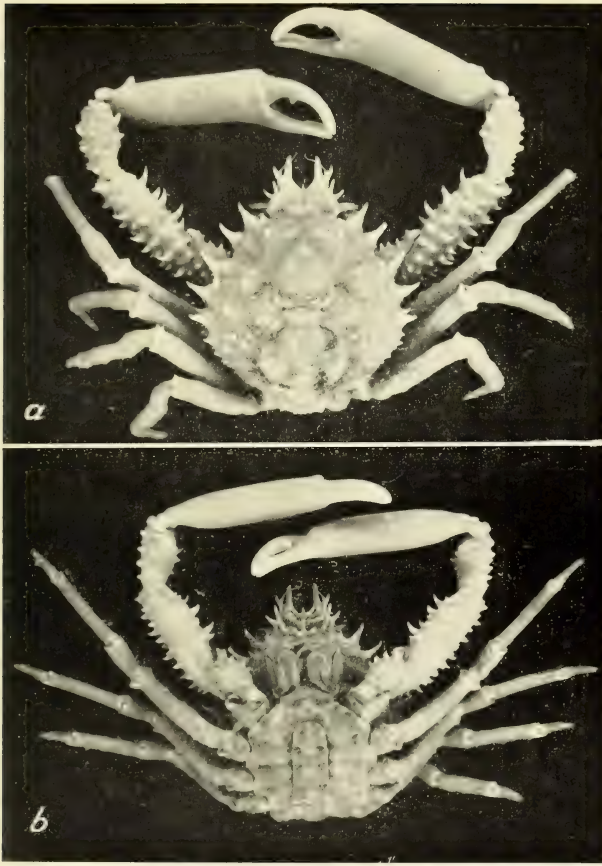
Photo:— C. V. Turner,
Australian Museum.

WASP FISH, *KARUMBA*

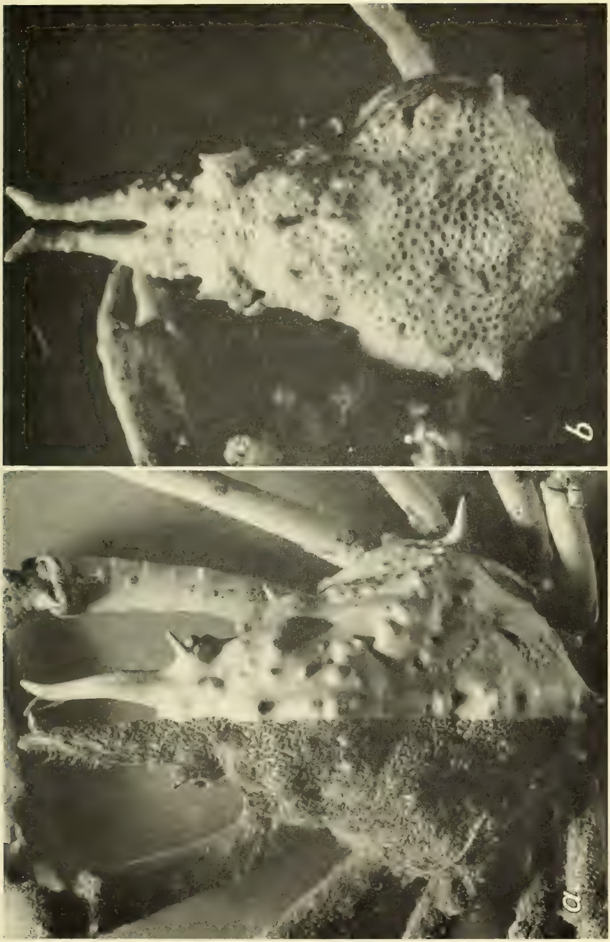
G. P. Whitley del.



SPIDER CRABS (for explanation see page 298).



SPIDER CRABS (for explanation see page 298).



SPIDER CRABS (for explanation see page 298).

DIPROTODON !!

EXTINCT MARSUPIAL

(For explanation see page 230).

From the original in the Mitchell Library, Sydney.

EXTINCT MARSUPIAL, *ZYGOMATURUS TRILOBUS* OWEN.

Gerard Krefft's illustrations of skull of holotype and his restoration of the complete animal, from the *Sydney Mail,* June 8, 1872, page 713, figs. 1-2. From the original in the Public Library of New South Wales, Sydney.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

MEMBERSHIP

(The Society's year commences on 1st July)

Fees are as follows:—

Class	*Amount of Subscription*
Associate Member	$ 2.10 per annum
Ordinary Member	$ 4.20 „ „
(Members joining 1st January in any year pay one-half subscription).	
Life Associate Member	$21.00 in one sum
Life Member	$42.00 „ „ „
Honorary Member	Elected for services to Australian Zoology or to the Society
Honorary Associate Member	Elected for services to Australian Zoology or to the Society
Junior Members (aged 16 or under)	50 cents per annum

TITLES

(Conferred by the Council)

Fellow		For valuable services to the Society or to Australian Zoology
Associate Benefactor	For contribution of $200.00	to the Society's Funds
Benefactor	„ „ $1,000.00	„ „ „ „
Endowment Member	„ „ $2,000.00	„ „ „ „

PRIVILEGES:

Members of all classes may attend all meetings of the Society and its various Sections. Every member (other than an Associate, Life Associate or Junior Member) receives a free pass to Taronga Zoological Park and Aquarium, and twelve tickets each year, admitting 12 adults or 24 children to the Park only.

APPLICATION FOR MEMBERSHIP

should be addressed to the Honorary Secretary, Royal Zoological Society of New South Wales, c/o Australian Museum, P.O. Box A.285, Sydney South, New South Wales.

PUBLICATIONS

The Australian Zoologist, published at irregular intervals since 1914. Twelve volumes to date.

Proceedings, published since 1933-34.

AUSTRALIAN ZOOLOGICAL HANDBOOKS AND SPECIAL REPRINTS.

"Bibliography of Australian Entomology, 1775-1930", by A. Musgrave, 1932.

"A Check List of the Birds of Paradise and Bower Birds," by T. Iredale, 1948.

"Revision of the New South Wales Turridae," by C. F. Laseron, 1954.

"The Published Writings of Tom Iredale, with an Index of his new Scientific Names," by D. F. McMichael & G. P. Whitley, 1956.

"A Reclassification of the Order Odonata," by F. C. Fraser, 1957.

"Dragonflies of Australia," by F. C. Fraser, 1960.

Orders and enquiries should be sent to the Honorary Secretary, Royal Zoological Society of New South Wales, c/o Australian Museum, P.O. Box A.285, South Sydney.

CONTENTS OF THIS PART

THE AUSTRALIAN ZOOLOGIST

Issued by the

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

VOLUME XIII — PART 4

DECEMBER 14, 1966

Price: One Dollar 50 ($1.50)

All communications to be addressed to the Hon. Secretary,
Royal Zoological Society of New South Wales,
c/o The Australian Museum,
P.O. Box A.285, Sydney South, N.S.W.

Registered at the G.P.O., Sydney, for transmission by post as a periodical.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

Established 1879

Registered under the Companies Act, 1899 (1917).

Patron:

His Excellency the Governor of New South Wales, Sir Arthur Roden Cutler, V.C., K.C.M.G., C.B.E., Kt.St.J.

Vice-Patron:

Sir Edward Hallstrom, K.B., F.R.Z.S.

COUNCIL, 1966-67

President:

Basil Joseph Marlow, B.Sc.

Vice-Presidents:

John Cameron Yaldwyn, M.Sc., Ph.D.
Ernest Jeffery Gadsden, F.R.Z.S.
Henry John de Suffren Disney, M.A.
Ronald Strahan, M.Sc.

Hon. Secretary: Mrs. Leone Harford

Hon. Editor: Gilbert Percy Whitley, F.R.Z.S., R.A.O.U.

Hon. Treasurer: John Miles Campbell, J.P.

Members of Council:

John Miles Campbell
Henry John de Suffren Disney
Ernest Jeffery Gadsden
Maxwell Hall Gregg
Lawrence Courtney-Haines, A.Mus.A., L.T.C.L.
John Hallstrom
Mrs. Leone Harford
Frank McCamley
Basil Joseph Guy Marlow
Anthony Irwin Ormsby, Ll.B.
Peter Edward Roberts, B.A.
Courtenay Neville Smithers, M.Sc.
Ronald Strahan, M.Sc.
Frank Hamilton Talbot, M.Sc., Ph.D.
Ellis Le Geyt Troughton, F.R.Z.S., C.M.Z.S.
Gilbert Percy Whitley
Mrs. Olive Wills
John Cameron Yaldwyn

OFFICERS

Honorary Solicitor:

Honorary Auditors: Messrs. Peat, Marwick, Mitchell and Company

Honorary Librarian:

Assistant Honorary Secretary: Mrs. Olive Wills

Assistant Honorary Treasurer: (Vacant)

Entomological Section:
Chairman: Mr. Rex Gilroy*
Hon. Secretary: Miss Mary Long

Conchological Section:
Chairman: Mr. F. McCamley
Hon. Secretary: Mrs. O. Wills

Junior Group:
Chairman: Mrs. L. Harford

Ornithological Section:
Chairman: Mr. P. E. Roberts*
Hon. Secretary: Mr. H. Battam

* Mr. L. C. Haines was Chairman in 1965-66 of both Entomological and Ornithological Sections.

THE AUSTRALIAN ZOOLOGIST

VOLUME XIII PART 4

OBSERVATIONS ON SOME AUSTRALIAN FOREST INSECTS

22. Notes on Some Australian Leaf-miners

By K. M. Moore

(Forestry Commission of New South Wales)

(Text figures 1-36)

SYNOPSIS

Information concerning Australian leaf-miners is limited, and in this paper some leaf-mining species of Coleoptera, Hymenoptera, Diptera and Lepidoptera bred from various host plants are recorded.

Although the extent of the biological studies of each species was necessarily restricted, the observations recorded add to the knowledge of the various groups of leaf-miners commonly encountered during forest entomological investigations in New South Wales.

INTRODUCTION

Forest trees, amenity trees and shrubs, or agricultural plants, at times may be severely attacked by leaf-miners, and the importance of damage caused by these insects may be classified broadly as either economic or aesthetic.

Comparatively few Australian leaf-miners are of economic importance, although a number of species associated with agriculture at times destroy or severely affect crops of potential food value to man, or to those animals on which man is dependent.

As most leaf-miners are minute insects, the effects of damage to trees and shrubs are usually insignificant unless large numbers of a particular leaf-miner species occur at the one time, when defoliation of trees over hundreds or thousands of acres of forest may occur (Moore 1963; Newman & Clark 1945) or when amenity plantings are severely affected (Hadlington 1954).

The number of species of these small or minute insects which feed within the tissues of leaves, is considerable, and most species belong to the order Lepidoptera (moths), although a few belong to the orders Coleoptera (beetles), Diptera (flies) and Hymenoptera (sawflies). They are called "leaf-miners" because they feed on, and mine between, the leaf tissues situated between the upper and lower leaf cuticles.

Some intensive studies of leaf-miners have been made in Europe (Hering 1951), America (Needham, Frost & Tothill 1928) and New Zealand (Watt 1924). This paper collates information on the biology, and illustrates some of the mines, of about 120 species indigenous to Australia, and refers to literature concerning introduced species.

LEPIDOPTEROUS LEAF-MINERS.

Evidence that lepidopterous leaf-miners occurred some 40 million years ago is recorded by Freeman (1965). Some species of lepidopterous leaf-miners complete their life-cycle within a few weeks, while others may produce only one generation each year. Eggs may be deposited either on the outside of the leaf cuticle or within the tissues below either the upper or the lower leaf cuticle. A particular oviposition site may be constant for a given family

or genus of moths. The type of leaf tissue in which larvae at times may feed and mine is sometimes associated with a discrete speices of leaf-miner or even a particular larval instar, and the shape of some mines may be typical for a certain genus, or species, of insect. Larvae may commence feeding in the epidermal cells immediately below either the upper or lower leaf cuticle and/or the palisade parenchyma; others may feed on the spongy parenchyma, or consume one or more cell layers. Others migrate internally from one side of the leaf to the other side, destroying only the epidermis in their early instars, and the upper or lower parenchyma during later instars; some destroy all of the parenchymous tissue, so that only the upper and lower leaf cuticles remain above and below the mine.

Leaf-mining larvae are comparatively soft and are relatively secluded in an area where they are surrounded by sappy plant tissues. During their early instars they are usually found in the young tender leaves of new plant growth, although leaves sometimes become fully developed before the larval stages are completed. Larvae of early sap-feeding instars usually possess mouthparts specialised for abrading the leaf cell walls (Moore 1953) to release the plant fluids necessary for their growth, but chewing mouthparts are typical of later instar larvae when the leaf tissues are ingested and the mine is considerably extended and deepened. Larvae may pupate either within the mine, or in cocoons spun on twigs or leaves, among debris on or near the ground, or in the soil.

A number of lepidopterous leaf-mining species construct typical mines differing in detail from those of all other species. The great diversity of mine patterns and sizes is of particular interest, and sometimes is of value in the determination of the insect species. Host association also appears to be of importance to some species.

Parasitism of leaf-miners usually occurs, varying considerably in the one locality and sometimes causing complete mortality for a given species. Braconid and chalcidoid wasps are the parasites most often reared from leaf-miners, and ants and small birds appear to be the principal predators.

Mines may be classified broadly as:—

Blotch:	These mines, usually about as wide as they are long, appear as blisters on the leaf surface (Figure 4).
Linear:	Larvae mine more or less directly forward (Figure 22).
Linear-blotch:	Construction of the linear portion precedes that of the blotch portion (Figure 2).
Serpentine:	This type of mine is long, narrow and sinuous, and of comparatively uniform width (Figure 14).
Serpentine-blotch:	The serpentine portion is usually constructed by an early instar larva, and the blotch portion by later instars (Figure 12).
Linear-expanded:	Mines are at first linear, then expanded distally into a small blotch-like area during the last instar (Figure 13).
Serpentine-expanded:	As the previous type, except that the early portion is serpentine (Figure 8).
Digitate:	As the name suggests, mines are constructed in various directions with the narrow prolongations appearing finger-like (Figure 1).

A. Family Gracilariidae.

Mines constructed by species in this family appear to be of similar general type and shape within each discrete genus, although they may differ considerably between genera.

Mines of the various species in the genus *Acrocercops* are similar in general appearance, and usually show characteristics distinct from those of other genera in this family. Early instar larvae usually construct a narrow, more or less linear type mine, although this portion of the mine is often obliterated during later instars as the blotch is constructed in the same general area of the leaf.

Acrocercops calicella (Stainton).

Mine type: Digitate-blotch (Figure 1).

Host: *Eucalyptus acmenioides* Schau.

Locality: Lisarow, N.S.Wales.

Notes: Oviposition usually occurs on the upper leaf surface and the early stage of the mine is constructed in the epidermal cells beneath the upper cuticle. Larvae are similar in shape and habits to those of *A. hoplocala*. The early instar larvae are sap-feeding and later instar larvae deepen the mine as most of the palisade and spongy parenchyma are destroyed. The mines are usually narrower and longer than those of *A. hoplocala,* and with the perimeter sinuate or digitate.

Larvae emerge from the mines to pupate either on their outer surfaces or along the leaf edge, when reared in jars. The cuticle of the mine is at first silvery white, but later becomes more darkly stained with brown than the mine of *A. hoplocala*. Granular excreta are distributed along the perimeter of the mine.

The cocoons, golden in colour, are spun in positions similar to those of *A. hoplocala* when held in jars. No globules have been found on or in the cocoons of this species.

Figure 1. Mine of *Acrocercops calicella* on *Eucalyptus acmenioides.*

Acrocercops chionosema Turner.

Mine type: Linear-blotch.

Host: *Macadamia integrifolia* Maiden & Betche.

Locality: Sydney to Queensland.

Notes: This species is referred to by Cann (1965) as mining in the upper surface of the leaves of the Queensland nut tree.

Mines occur on *M. integrifolia* during spring and autumn at Sydney. They may be up to 60 mm. in length, with the blotch portion always across and along the centre vein of a leaf. The blotch area has markings of a rusty red-brown colour caused by the lines of excreta within the mine. Last instar larvae deepen the mine, and affected leaves bear patches of brown where tissues have died beyond the mine.

Acrocercops hoplocala Meyrick.

Mine type: Linear-blotch (Figure 2).

Host: *Eucalyptus saligna* Smith.

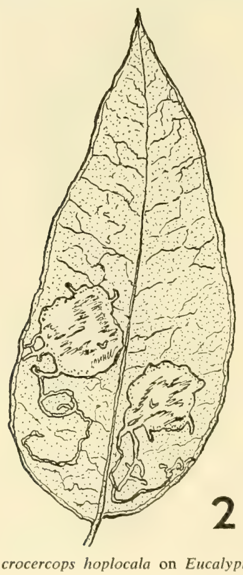
Localities: Sydney; Gosford-Wyong area, N.S.Wales.

Notes: Larvae have been collected during March, May to September, and November to January.

Oviposition always occurs on the upper leaf surface, and the egg is visible as a silvery spot at the commencement of the linear portion of the mine, or on the blotch portion when it has obliterated the commencement of the linear portion.

The larva mines directly into the leaf tissues through the base of the egg attached to the cuticle. The upper epidermis is destroyed during early instars when the linear portion of the mine is constructed.

Both the linear and the blotch portions are white, but pale brown staining from the excreta of the early sap-feeding instar larva is sometimes evident. Larvae are similar in appearance to those of *A. laciniella,* with typical prognathous



2

Figure 2. Mine of *Acrocercops hoplocala* on *Eucalyptus saligna.*

sap-feeding mouthparts during early instars, but with the more usual lepidopterous mouthparts as the blotch area is constructed during later instars when portions of the blotch are irregularly deepened and most of the palisade and spongy parenchyma is destroyed.

The linear portion of the mine is completed in about 10 to 14 days, and the blotch portion in a further 6 to 8 days. The larva emerges from the mine through a semi-circular slit cut in the upper cuticle, and pupates in a white to pale yellow cocoon which may be attached to the leaf or the blotch mine cuticle when specimens are reared in jars. No globules have been found attached to cocoons of this species although they usually occur on or in the cocoons of some other species of the family Gracilariidae.

A single mine usually occurs in almost any position on the upper leaf surface, but occasionally two mines may be present. The blotch sometimes may be extended so that, when completed, only small lengths of the linear portion are visible, but more usually, most of the linear portion remains. The pellets of excreta voided by the later instar larva are distributed in a broken line around the perimeter of the mine. A purplish discoloration is usually present in the leaf tissues outside the perimeter of the mine on the upper surface of the leaf, while a slight purplish suffusion on the lower surface is often the only indication of the presence of the mine above.

During early spring, the time occupied from eclosion to pupation is about 3 weeks, adults emerging about 3 weeks later.

Larvae of the Braconini (Braconidae) are ectoparasitic on larvae of *A. hoplocala,* and they construct silken cases near the centre of the mine in which to pupate, and which are surrounded by a thin black line of lepidoptera pellets.

Acrocercops laciniella (Meyrick).

Mine type: Linear-blotch.

Hosts: *Angophora costata* (Gaertn.) Druce; *A. floribunda* (Smith) Sweet; *Eucalyptus pilularis* Smith; *E. saligna; E. acmenioides.*

Localities: Sydney; Lisarow; Gosford; Norah Head; Olney East State Forest, N.S.Wales.

Some biology of this species, with figures of mines and details of larvae, have been recorded previously (Moore 1963).

Acrocercops macaria Turner.

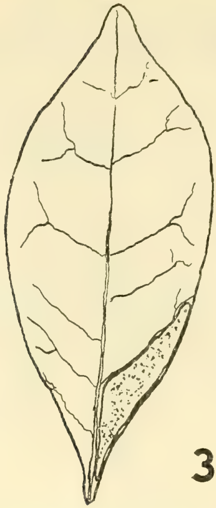
Mine type: Blotch (Figure 3).

Host: *Euodia micrococca* F. Muell.

Locality: Ourimbah State Forest, N.S.Wales.

Notes: Larvae have been collected during September. During early larval instars the mines are shallow, but they are deepened during later instars, so that only the upper and lower cuticles of the leaf remain covering the mined area. The lower cuticle of the mine is at first white, later becoming suffused with pink. Excreta are distributed randomly throughout the mine.

Mines are comparatively small (about 8 mm. long and 5 mm. wide), always occur below the hairy undersurface of the leaves, and are usually bounded by the mid-vein, the edge of the leaf near its base, and two adjacent secondary veins, although some mines occur further along the leaf toward the tip.



3

Figure 3. Mine of *Acrocercops macaria* on *Euodia micrococca.*

Larvae are at first cream, becoming increasingly suffused pinkish orange, and when about to pupate are pink with reddish transverse markings. They emerge from the mine through a crescentic slit cut in the cuticle, usually at the distal end of the mine, to pupate in silken cocoons constructed on the leaf surface when held in jars.

The pupal exuviae is protruded from the cocoon before the adult emerges. Adults emerged during October.

Acrocercops ordinatella (Meyrick).

Adults of this species were reared from larvae collected near Coff's Harbour, N.S.Wales, during February, mining in the leaves of a one-year-old plant of *Cinnamomum camphora* (L.) Nees. Adult moths emerged during February.

Acrocercops plebeia (Turner).

Mine type: Linear-blotch.

Host: *Acacia podalyriifolia* A. Cunn. ex G. Don.

Locality: N.S.W. and Queensland.

Notes: This species on the above host, and some of its biology, is recorded by Froggatt (1927).

Mines may occur on both sides of the leaves and cover most of the leaf surfaces, so that little of the linear portion of the mine is eventually discernible.

Larvae collected during 16 February at Sydney, emerged as adults on 3 March. Larvae constructed their deep cream cocoons on the base of the rearing jar

Acrocercops sp. near *argyrodesma* (Meyrick).

Mine type: Linear-blotch.
Host: *Hakea salicifolia* (Vent.) B. L. Burtt.
Locality: Ourimbah State Forest, N.S.Wales.
Notes: Foliage of the attacked shoots becomes brown and distorted, with the death of some shoots occurring distally.

From larvae collected and reared during November and December, adults emerged during December and January. The life cycle occupied about 5 weeks.

Acrocercops sp. nov. ? (in *laciniella* group)

Mine type: Blotch.
Host: *Eucalyptus radiata* Sieb.
Locality: Kanangra Walls, N.S.Wales.
Notes: Larvae collected during August spun their golden-brown cocoons on the cuticles of the mines when reared in jars, and adults emerged during October.

The blotch mine is round to oval, white, and without brown staining, and as many as 3 mines may occur on the one leaf. The linear portion is usually obliterated by the blotch portion which may cross the mid-vein of the leaf.

Acrocercops sp.

Mine type: Blotch (Figure 4).
Host: *Asterolasia correifolia* Benth.
Locality: Ourimbah State Forest, N.S.Wales.
Notes: Several somewhat tortuous, silvery linear type mines in the upper epidermis of a leaf sometimes radiate from the one centre of oviposition. All the parenchyma is consumed as the blotch area is completed, so that most, if not all, of the linear portion is obliterated by the blotch portion. The mines always spread each side of the mid vein.

Larvae leave the mine through a crescentic shaped slit in the cuticle of the upper leaf surface, to pupate on the leaf or on the cuticle of the mine when reared in jars. Numerous globules may occur on the cocoon, and the pupal exuviae is protruded from the cocoon before the adult emerges.

4

Figure 4. Mine of *Acrocercops* sp. on *Asterolasia correifolia*.

Pupation occupied about 2 to 3 weeks during October, and adults emerged during October and November.

Braconid wasps were reared from larvae of this species.

Acrocercops sp.

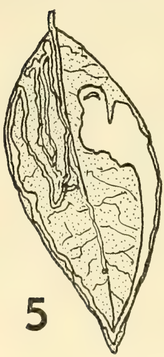
Mine type: Linear-blotch.
Host: *Pomaderris ligustrina* Sieb. ex DC.
Locality: Lisarow, N.S.Wales.

The biology of this species is very similar to that of the previously mentioned species, but the mines do not always spread each side of the mid-vein.

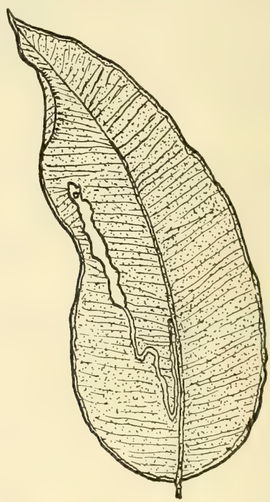
Gracilaria xanthopharella Meyrick.

Mine type: Linear-expanded (Figure 5).
Host: *Glochidion ferdinandi* J. Muell.
Locality: Gosford area, N.S.Wales.

Notes: The mine of this species of *Gracilaria* has characteristics distinct from those of the species studied in other genera of the family Gracilariidae. It is at first white and tortuous, with the latter half of the completed mine pale brown, and more or less extending into a blotch at its distal end. Cocoons are spun on the leaf or on the container used for rearing the specimens. Larvae were collected during August and September.



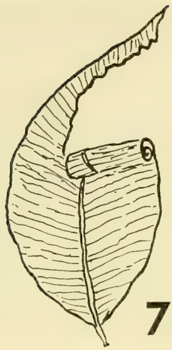
5



6

Figure 5. Mine of *Gracilaria xanthopharella* on *Glochidion ferdinandi*.

Figure 6. Leaf of *Angophora floribunda* showing mine and pupation site of *Parectopa ida*.



7

Figure 7. Leaf curled by larva of *Parectopa ida.*

Parectopa ida (Meyrick).

Mine type: Linear-expanded (Figures 6 and 7).

Hosts: *Angophora floribunda; Eucalyptus acmenioides; E. gummifera* (Gaertn.) Hochr.; *E. paniculata* Smith; *E. pilularis; E. robusta* Smith; *E. saligna.*

Localities: Sydney; Gosford-Wyong area; Norahville, N.S.Wales.

Notes: The mines and habits of *P. ida* are distinct from those of the species studied in the other genera of this family.

In the Lisarow area, the host most heavily attacked was *A. floribunda,* and larvae were collected during the months of March and May to November.

Oviposition occurs only on the lower surface of a leaf, the egg being placed on the external leaf cuticle. After emergence of the larva, the more or less oval chorion, about 0.6 mm. in diameter, is visible as a minute silvery spot on the leaf surface at the commencement of the mine.

Larvae emerge through that portion of the chorion attached to the leaf cuticle, and so commence mining in the leaf tissues, thus obviating their exposure on the leaf surface. Mines usually occur only in the comparatively young and succulent leaves of epicormic, coppice and regeneration growth of the various host plants.

During the first instar, when larvae do not possess the more usual lepidopterous mandibles, only the epidermal layer of cells is destroyed. The mandibles are flat, plate-like structures with rounded and serrated anterior edges utilised for cutting and bruising the cells to release the fluids which are conveyed along grooves on their surfaces. The head capsule is extremely flattened dorso-ventrally, with prognathous mouthparts. Both types of mandibles, which have been figured previously (Moore 1963), are similar to those of *A. laciniella.* Larvae are thus peculiarly adapted to mine proficiently in a very restricted area. The head capsule is protrusible anteriorly.

For about 11 days after eclosion, the larva mines forward to form a narrow linear mine through the epidermal cells with only the thin cuticle of the leaf remaining above it. The mine is visible as a silvery-white line which

is variable in length and position on the leaf. The linear portion of the mine may extend for about 50 mm. to 60 mm., and gradually increases in width from the diameter of the egg to more than 1 mm. where it adjoins the expanded area.

On completion of the linear portion, the larva undergoes ecdysis, when its mouthparts become the more usual lepidopterous type. For about 3 days after the larva recommences to feed, it continues to mine forward, but the resulting mine now becomes wider and deeper, assuming the form of an elongate expanded area about 20 mm. long and 2.5 mm. wide. This area becomes tan-brown in colour soon after the tissues are destroyed. On the upper leaf surface opposite to the mine, is an elongate pale green or yellow-green to red-brown area corresponding more or less to the shape of the mine below. As the expanded portion is extended, the palisade and portion of the spongy mesophyll of the leaf are destroyed, and a fine web spun over the internal upper surface of the mine causes the thin "roof" of the mine to be raised for all of its length into a gable-shaped ridge over the larva. When the young leaf is actively growing, or when the mine is close to its outer edge, distortion of the leaf occurs in that area. The larva then commences to deepen the expanded area by consuming the remaining parenchyma. This may occupy about 6 days, with a total of 9 to 11 days from the commencement of the expanded area. Last instar larvae are pale yellow and about 8 mm. to 9 mm. in length.

After the deepening of the expanded area, the larva emerges through a round hole cut in the ridged cuticle near the end of that area. From the mine, it moves to the leaf tip where it spins thick strands of silk which adhere to the surface of the leaf. The tip of the leaf is thus curled approximately twice, into a tube-like structure in which the larva continues to feed on the ventral surface of the leaf forming the tube. The leaf may also be cut by the larva, longitudinally from the tip, with the cut forming one extremity of the tube and the leaf edge the other extremity (Figure 7). Should leaves be in contact, larvae may tie them together with silken threads and feed within that area, instead of constructing the tube.

Mines may occur almost anywhere on the lower surface of a leaf, and the linear portion may cross the mid-vein, usually toward the distal end of the leaf. The excreta of larvae during the early sap-feeding instars is visible as a faint brownish stain on the cuticle, usually along the centre of the silvery-white portion. When the larva attains its more typical lepidopterous mouthparts and commences to ingest the tissues with the sap, the excreta become granular and loose in the expanded area of the mine. The linear portion of the mine is constructed by the first two larval instars, the remaining two instars constructing the expanded area and curling the leaf.

When about to pupate, the larva leaves the tube and proceeds to the edge of a leaf (not necessarily the one it has curled) where, by means of a strong web of silk, a small portion of the edge becomes folded over to form a shelter where the larva spins its cocoon of shiny white silk (Figure 6). Attached to the internal or external surface of many of the cocoons is a variable number of minute globules composed of a shiny white substance. From eclosion of the larva to pupation is about 3 weeks.

The pupa fractures the cocoon by means of a series of spinous processes on the anterior tip of the exuviae and which are similar to those on the pupa of *A. laciniella* (Moore 1963, Fig. 5). The exuviae protrudes for about two-thirds of its length from the end of the cocoon prior to the moth emerging, about 3 to 6 weeks after the construction of the cocoon.

The adult moth, with a wing span of about 11 mm. and a length of 4 mm. is prominently marked with red, yellow, black and white.

The life cycle from the egg to the adult occupies about 6 to 9 weeks, early instar larvae collected during July emerging as adults during August and September.

Wasps of the Chalcidoidea and Ichneumonidae have been reared from specimens collected at Lisarow, N.S.Wales.

Phyllocnistis diaugella Meyrick.

Mine type: Serpentine (Figure 8).

Host: *Breynia oblongifolia* J. Muell.

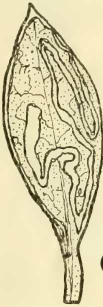
Locality: Lisarow-Wyong area, N.S.Wales.

Notes: Mines of species in this genus have characteristics distinct from those in other genera of this family. All of those mines examined were situated on the upper surface of the leaves, and the white silvery cuticle of the mine was stained with a narrow pale to dark brown sinuate mark caused by the larval excreta. A mine of this species occupies most, or all, of the upper leaf surface.

Larvae were collected during September, and pupation occupied about 16 days during that month.

8

Figure 8. Mine of *Phyllocnistis diaugella* on *Breynia oblongifolia.*



9

Figure 9. Mine of *Phyllocnistis* sp. on *Hibbertia scandens.*

Phyllocnistis sp. (probably sp. nov.)

Mine type: Linear-expanded (Figure 9).

Host: *Hibbertia scandens* (Willd.) Gilg.

Locality: Lisarow, N.S.Wales.

Notes: Larvae at first construct an extensive linear type mine in the lower parenchyma, then migrate internally to the upper palisade layer alongside the mid-vein near the base of the leaf, to complete their mines. Mines are visible as a pale pinkish linear marking on the lower surface, and a reddish-brown serpentine area more or less conforming to the shape of the mine, on the upper surface. Mines are similar to, but usually larger than, those of *P. diaugella.*

The excreta, which are deposited in a sinuate line transversely, stain the mine cuticle dark brown, similar to mines of *P. diaugella.* The leaf is drawn into a crease or fold along the distal portion of the mine where the cocoon is constructed, and where the larva pupates.

Larvae were collected during September and February.

Pupation occupies about 12 days during September, and the pupal exuviae is protruded from the extremity of the mine as the adult emerges.

B. Family Nepticulidae.

The mines of the various species in this family of moths are more readily separable than are those of species in the family Gracilariidae, and it appears that most species may be determined by the structural differences shown in the mines. The species of leaf-miners occurring in this family are among the smallest moths known, and adults are usually dark coloured, sometimes with a metallic suffusion and a few white scales.

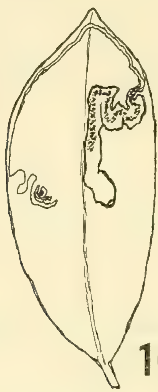
Nepticula phyllanthina Meyrick.

Mine type: Serpentine-linear-expanded (Figure 10).

Host: *Glochidion ferdinandi.*

Locality: Sydney; Lisarow, N.S.Wales.

Notes: Oviposition occurs on the under surface of a leaf, usually close to the leaf edge, the larva entering the leaf through the chorion to commence mining below the upper cuticle. When the mine is completed, larvae cut an oval hole in the distal extremity of the mine on the lower leaf surface and fall to the ground where a minute white cocoon is constructed in the soil.



10

Figure 10. Mine of *Nepticula phyllanthina* on *Glochidion ferdinandi.*

Larvae were collected during August, pupation occupying about 4 weeks during spring, and the pupal exuviae is protruded from the end of the cocoon before the adult moth emerges.

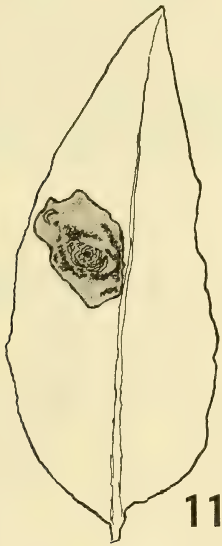
Nepticula ? funeralis Meyrick.

Mine type: Serpentine-blotch (Figure 11).

Hosts: *E. acmenioides; E. pilularis.*

Locality: Lisarow, N.S.Wales.

Notes: Oviposition occurs anywhere on the upper leaf surface, and larvae commence mining beneath the upper cuticle. The egg may be seen as a brown shiny speck on the leaf.



11

Figure 11. Mine of *Nepticula ? funeralis* on *Eucalyptus acmenioides.*

The mine appears as a dark brown blotch on the upper leaf surface, while on the lower leaf surface a brown area denotes its position. It is at first serpentine for a comparatively short distance, then enlarges to form a blotch, which is often restricted by the venation of the leaf. Larvae cut through the upper cuticle at the distal end of the mine, and fall to the ground where they pupate. Larvae leaving mines during July emerge as adults during the following March.

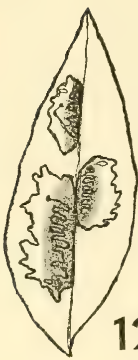
Larvae are pale green, with a dark median stripe which is due to the presence of recently ingested leaf tissues in the alimentary tract.

Nepticula sp. (in *funeralis* ? group).

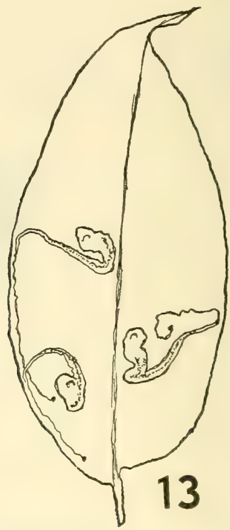
Mine type: Serpentine-blotch (Figure 12).
Hosts: *E. saligna; E. grandis; E. microcorys* F. Muell.
Locality: Lisarow; Ourimbah State Forest, N.S.Wales.
Notes: Oviposition occurs on the upper leaf surface. On leaving the mine, larvae make an oval hole in the lower leaf cuticle, fall to the ground and pupate in small golden-coloured cocoons under debris on the ground.

Position of the mine on the leaf is variable, but it usually occurs near the mid-vein. The early portion is serpentine, with the blotch area superimposed and extended laterally. Excreta are compacted along that side of the mine nearest to the mid-vein.

Larvae collected during July emerged as adults during the following March.



12



13

Figure 12. Mine of *Nepticula* sp. on *Eucalyptus saligna.*

Figure 13. Mine of *Nepticula* sp. No. 1 on *Eucalyptus saligna.*

Nepticula sp. No. 1 (near *libera*).

Mine type: Linear-expanded (Figure 13).
Hosts: *E. saligna; E. acmenioides; E. grandis; A. floribunda.*
Localities: Lisarow; Pennant Hills, N.S.Wales.
Notes: Oviposition and the mines occur on the upper leaf surface, up to 3 mines occurring on the one leaf. Larvae leave the mines at dusk through a crescentic slit made in the upper leaf cuticle at the distal end of the mine. Larvae have been collected during May to December, those collected during

the first week in July emerging as adults approximately 7 to 8 weeks later, and those larvae which emerge from the mines during May, become adults during July. Last instar larvae are orange with the digestive tract green.

The mine is reddish-purple proximally, then reddish-pink to the expanded portion from where it is cream-fawn in colour. Excreta may be seen through the leaf cuticle as dark areas in the first portion of the mine, and later fill the early part of the expanded portion. As the mine is expanded, the black excreta appear at the side of the mine, and the line is forked distally near where the larva emerges.

Pupation occurred in the soil when held in jars, and the pupal exuviae protruded from the soil as the adults emerged.

Nepticula sp. No. 2 (near *funeralis* or *melanotis*).

Mine type: Serpentine (Figure 14).
Hosts: *E. saligna; E. acmenioides; E. pilularis; A. floribunda.*
Locality: Lisarow, N.S.Wales.
Notes: Eggs are placed on the upper leaf surface. Unlike the previous species, larvae leave the mine through a semi-circular slit made in the ventral leaf cuticle. Larvae collected during September pupated and emerged as adults about 6 weeks later. Some collected during July emerged during August. Last instar larvae are bright green in colour. After leaving the mine, larvae spin a flattened tan-brown cocoon on debris or just below the soil surface, the pupal exuviae being protruded from the end of the cocoon when the adult emerges.

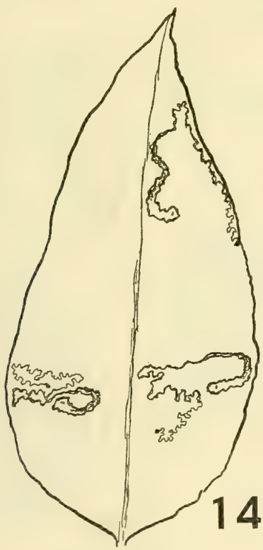


Figure 14. Mine of *Nepticula* sp. No. 2 on *Eucalyptus saligna.*

Mines occur on the upper surface of a leaf, but their position is variable on the leaf. The proximal portion of the mine is filled with excreta which appear red-brown on the upper leaf cuticle, while excreta in the distal portion are black, and placed centrally in the mine. There is a minute red area where the egg is deposited on the leaf surface. During early instars, a silvery-white, tortuous linear mine is constructed, and during the later instars the mine appears creamy white with a central line of excreta appearing black on the cuticle.

Five specimens of a chalcidoid parasite emerged from one mine during August.

Figure 15, 15a. Mine of *Nepticula* sp. No. 3 on *Eucalyptus saligna.*

Nepticula sp. No. 3 (near *gilva*).

Mine type: Serpentine-expanded (Figures 15 and 15a).
Hosts: *E. saligna; E. acmenioides; E. pilularis.*
Localities: Lisarow; Pennant Hills, N.S.Wales.

Notes: Oviposition occurs on the dorsal cuticle of the leaf, and larvae emerge from the mines through a slit cut in the ventral leaf cuticle. They spin a tan-brown oval pupal case of coarse silk among debris on the ground. Larvae collected during July emerged as adults about 12 weeks later, the pupal exuviae protruding from the end of the cocoon after emergence of the adult. Larvae have been collected during June to September, January, March and April.

The peculiar shape of the mine of this species is distinctive. The early linear portion is constructed in contiguous circles outward from the egg capsule until the circular area is about 4 mm. to 5 mm. in diameter, so that the egg capsule is thus at the approximate centre of the circular area. In the circular area, mining occurs mainly in the palisade layer, but in later stages all of the parenchyma is destroyed so that this portion of the mine is translucent. The central circle of the mine is deep red in colour on the upper leaf surface, but is seen as an irregular brown patch on the lower surface. Position of the mine on a leaf is variable, and there may be several on one leaf.

Larvae may be yellow-green, yellowish or pinkish-orange to bright purple in colour.

Apanteles sp. (Braconidae) parasitises larvae of this species.

Nepticula sp. No. 4 (near *caenodera* or *endocapna*).

Mine type: Serpentine-expanded (Figure 16).
Hosts: *E. acmenioides; E. saligna; E. pilularis; E. microcorys.*
Locality: Lisarow; Olney East State Forest, N.S.Wales.

Notes: Eggs are laid on the dorsal surface of a leaf, and larvae have been collected during April and June to January. Last instar larvae are

Figure 16. Mine of *Nepticula* sp. No. 4 on *Eucalyptus acmenioides.*

bright green with a black median dorsal marking, and they emerge through a crescentic slit cut in the upper leaf cuticle. They pupate in the soil in white silken cocoons, or on debris on the ground.

From pupation to emergence of the adult occupies about 8 weeks during early spring.

Position of the mine is variable from the base to the tip of a leaf, and its shape is distinctive. The palisade layer only is mined during the early instars, but both the palisade and the spongy parenchyma are destroyed in the expanded portion of the mine. When the upper epidermis and palisade, and the upper and lower spongy parenchyma are destroyed, a network of small leaf veins, and the oil glands, remain on the floor of the expanded portion of the mine. The upper cuticle of the expanded portion becomes light to tan-brown in colour, and black narrow lines of excreta are plainly visible adhering to the upper cuticle of the mine. The early serpentine portion is red-brown to black in colour.

A single braconid specimen, or 9 chalcidoid specimens, have emerged from one larva of this species of leaf-miner

Nepticula sp. No. 5.

Mine type: Serpentine (Figure 17).
Hosts: *E. acmenioides; E. pilularis.*
Locality: Lisarow, N.S.Wales.
Notes: The transparent bright green or purple last instar larvae emerge from the mine through the ventral leaf cuticle. Ingested food is clearly visible through their cuticle as a red median stripe. Larvae pupate in tan-brown silken cocoons just below the soil surface or on leaves, when

17

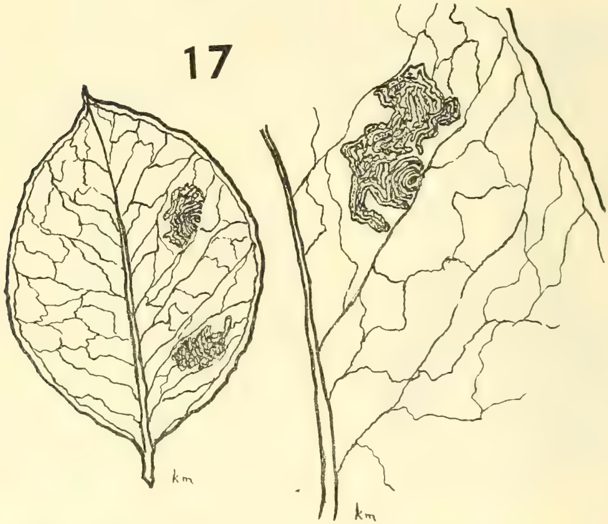


Figure 17. Mine of *Nepticula* sp. No. 5 on *Eucalyptus pilularis.*

reared in jars. The pupal exuviae is protruded from the end of the cocoon at the emergence of the adult. The time from the spinning of the cocoon to the emergence of the adult is about 8 months. Larvae were collected during June and July.

The position of the mine on a leaf is variable, and more than one mine may be found on the one leaf. Mines are tortuous, with the galleries contiguous, and the egg capsule is visible as a silvery spot on the dorsal cuticle near the centre of the mine. Mines are reddish-purple at first, later portions sometimes being silver in colour. The restricted translucent area denotes the distal end of the mine.

18

Figure 18. Nepticulid mine on *Asterolasia correifolia.*

Nepticulidae.

Mine type: Serpentine (Figure 18).
Host: *Asterolasia correifolia.*
Locality: Ourimbah State Forest; Lisarow, N.S.Wales.
Notes: Oviposition occurs on the upper leaf surface. Larvae have been collected during September, and February and March, and they leave the mine through a semicircular slit in the upper leaf cuticle. Mines are to be found on the upper leaf surface, and a dark central line of excreta may be seen in the mine.

Nepticulidae.

Mine type: Serpentine.
Host: *Pomaderris ligustrina.*
Locality: Lisarow, N.S.Wales.
Notes: Mines of this species are similar to those of the previous species.

Nepticulidae.

Mine type: Serpentine-linear-blotch (Figure 19).
Host: *E. acmenioides.*
Locality: Lisarow, N.S.Wales.
Notes: Larvae were collected during July. Eggs are laid on the dorsal leaf surface, and larvae leave the mines through the dorsal surface.

Figure 19. Nepticulid mine on *Eucalyptus acmenioides.*

Position of the mines on a leaf is variable, but usually close to the mid-vein of the leaf. The early part of the mine is reddish-brown with the linear portion light brown, the blotch area being darker brown. Frass is central in the linear portion, then distributed in small groups in the blotch area.

Nepticulidae.

Mine type: Serpentine (Figure 20).

Hosts: *E. acmenioides; E saligna; E. microcorys.*

Locality: Lisarow; Olney East State Forest, N.S.Wales.

Notes: The pale to bright green larvae have been collected during July, August, January and March. Oviposition occurs on the upper leaf surface, and the larvae leave the mine on the lower leaf surface to spin small dark brown cocoons on the base of the jar. The pupal exuviae is protruded from the case at emergence of the adult.

Mines usually occur on mature leaves of *E. acmenioides,* and on semi-mature leaves of *E. saligna*, and their position on the leaf is variable. The serpentine portion of the mine is seen as a thin grey line, with the digitate portion darker in colour. The distal portion is greyish-green, and the digitate part appears to be constructed solely in the spongy parenchyma. Excreta are seen as a black central line in the serpentine portion, and the edges of the excreta appear to follow the contours of the digitate portion.

Up to 4 chalcidoid specimens of parasites have emerged from one larva.

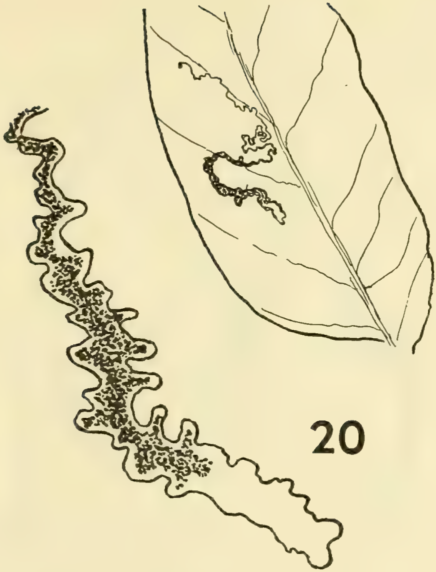


Figure 20. Nepticulid mine on *Eucalyptus saligna*.

Nepticulidae.

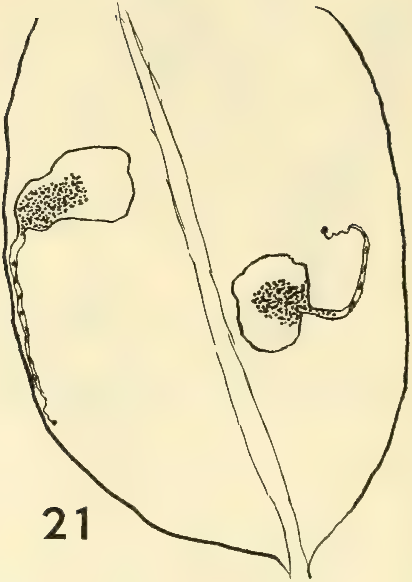
Mine type: Linear-blotch (Figure 21).

Host: *Angophora floribunda*.

Locality: Lisarow, N.S.Wales.

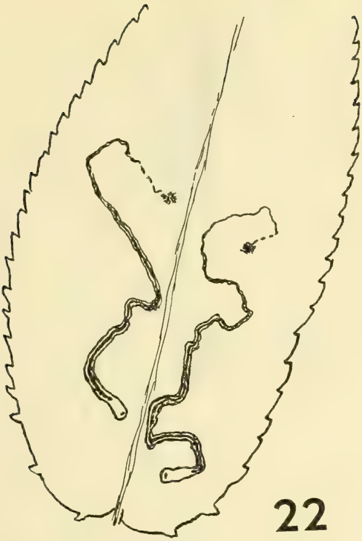
Notes: Oviposition usually occurs on the dorsal surface of a leaf, usually near the edge of the leaf. Last instar larvae make their exit through a crescentic slit on the ventral leaf surface, at the distal end of the blotch portion. Larvae were collected during October to December, and the time from pupation to the emergence of the adult is about 6 weeks.

Position of the mine on a leaf is variable, but usually toward the leaf edge. Up to 6 mines may occur on one leaf. Excreta of larvae may be spread over the central portion of the blotch area with the edges of the blotch remaining clear, and the mine perimeter is usually surrounded by a narrow line of purple staining.



21

Figure 21. Nepticulid mine on *Angophora floribunda*.



22

Figure 22. Nepticulid mine on *Rubus moorei.*

Nepticulidae.

Mine type: Linear (Figure 22).

Host: *Rubus moorei* F. Muell.

Locality: Lisarow, N.S.Wales.

Notes: Eggs are deposited within the leaf tissues, and the early portion of the mine is not visible on either leaf surface. The oviposition site is denoted by a reddish spot on the dorsal cuticle. Larvae were collected during September, mining in the dorsal area of a leaf. They leave the pale brown coloured mine from the dorsal surface, to pupate in small whitish cocoons on leaves or on the soil surface when reared in jars. Larvae are pale orange in colour.

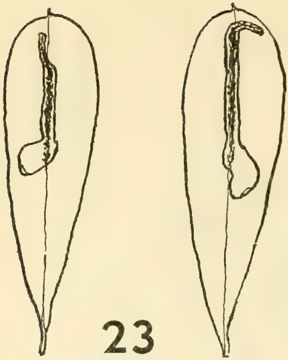
Nepticulidae.

Mine type: Linear-expanded (Figure 23).

Host: *Banksia integrifolia* L.f.

Locality: Boat Harbour (Central Coast), N.S.Wales.

Notes: Larvae leave the mines from the upper leaf surface.



23

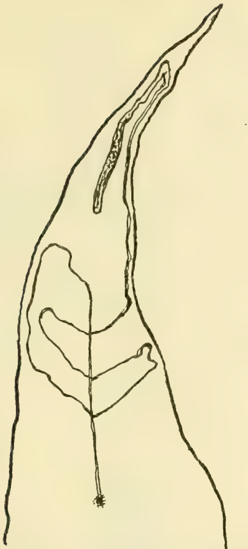
Figure 23. Nepticulid mine on *Banksia integrifolia*.

24

Nepticulidae.

Mine type:	Linear (Figure 24).
Host:	*Banksia serrata* L.f.
Locality:	Boat Harbour, N.S.Wales.
Notes:	Larvae leave the mines from the lower leaf surface.

Figure 24. Nepticulid mine on *Banksia serrata*.



25

Figure 25. Mine of *Heliozela prodela* about half constructed on *Eucalyptus acmenioides.*

C. Family Heliozelidae.

Heliozela prodela Meyrick.

Mine type: Linear-blotch (Figure 25).

Hosts: *A. floribunda; E. acmenioides; E. saligna; E. pilularis; E. gummifera.*

Localities: Lisarow; Sydney, N.S.Wales.

Notes: Oviposition occurs in the mid-vein from ¼" to 1" from the tip of a leaf, and the site is denoted by callous tissue. Larvae have been collected during May to July. First instar larvae mine along the mid-vein toward the tip of a leaf, then back and forth across the tip in the secondary venation; or they may first mine along a lateral vein toward the leaf edge, then along the vein just inside the leaf edge, to return to the mid-vein and then back and forth across the leaf tip 3 or 4 times in the secondary venation. The mines become red and are prominently visible against the green leaf. The area distal to the basal line of the mine becomes pale green to yellow. The last instar larva mines down along the mid-vein for a variable distance, then mines most of the parenchyma in the leaf tip, thus forming a blotch mine. This area turns light brown dorsally, and from this area a small convex oval case about 4 mm. by 2 mm. is cut out either on or near the mid-vein, and within the area of previous mining, and shed from the leaf. The dorsal

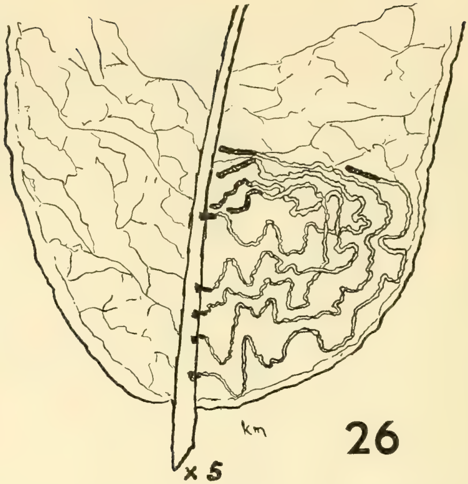


Figure 26. Early stage of heliozelid mines on *Eucalyptus saligna.*

side of the case is dark grey and the ventral side light grey on *A. floribunda.* The internal surface of the case is covered with white silk.

The early portion of the mine may be destroyed as the blotch area is constructed, and there is usually an area of staining around the mine. More than one mine may occur on a leaf.

Cases may be constructed during May, June and January, so that there appears to be more than one generation each year. From those cases constructed during May, adults emerged during September. The pupal exuviae protrudes from the end of the case as the adult emerges.

Heliozelidae.

Mine type: Linear-blotch (Figure 26).

Hosts: *E. saligna; E. grandis; E. acmenioides.*

Locality: Lisarow, N.S.Wales.

Notes: Oviposition occurs at the edge of the mid-vein on the ventral leaf surface, where a swelling of the tissues may be seen. Up to 6 eggs may be placed more or less contiguously, resulting in an area of dead tissue on the vein, and the base of the leaf below the mines becomes grey-green, often to dry out before the larvae mature. Larvae commence mining in the spongy parenchyma only, moving toward the leaf edge, then turn to cross the mid-vein after about 7 days.

Early portions of the mines are constructed in a forward direction only, and larvae fit closely in the mines which are not extended laterally until the blotch area is commenced. The small, fine venation of the leaf is retained on the leaf cuticle inside the blotch area, so that the pupal cases cut from the blotch area show the darker green network of the venation against the cream-coloured background. From the commencement of the cutting out of the pupal case until its completion and separation from the leaf, occupies

Figure 27. Heliozelid mine on *Eucalyptus pilularis.*

about 7 hours, and the time taken from the commencement to completion of the mine is about one month during June and July. From larvae collected during May to July, adults emerged during September.

Larvae are translucent yellow-green.

Heliozelidae.

Mine type: Linear (Figure 27).

Hosts: *A. floribunda; E. pilularis.*

Locality: Lisarow, N.S.Wales.

Notes: Oviposition occurs between the mid-vein and the edge of the leaf toward its base, and the area is surrounded by a deep red, more or less circular, stain. Larvae were collected during June and September.

After usually mining to the edge of the leaf, the larva continues to mine along the edge for a short distance, then back to the mid-vein which is followed toward the tip of the leaf for about two-thirds of its length. The early mine appears as a thin red line and the mid-vein turns black. Young larvae sometimes mine to the mid-vein before reaching the side of the leaf, mine to its base, then turn upward toward the tip of the leaf. The entire leaf becomes pink, and then yellow-pink, and falls to the ground.

Last instar larvae are deep pink, and construct cases by diverging from the mid-vein for a short distance, constructing a restricted blotch area contiguous to the vein, where a pupal case is constructed. This case is lined with silk and is usually attached at an angle to an object by means of a small pad of silk at the end of the case.

28

Figure 28. ? Heliozelid mine on *Eucalyptus stricta*.

? Heliozelidae.

Mine type: Linear (Figure 28).

Host: *Eucalyptus stricta* Sieb.

Locality: Kanangra Walls, N.S.Wales.

Notes: Oviposition occurs toward the base of the leaf, between the mid-vein and the edge of the leaf, usually two-thirds to three-quarters of the distance from the tip to the base. Larvae were collected during August.

Mining toward the base of the mid-vein, the larva then crosses the mid-vein and continues toward the tip of the leaf for a distance about equal to that on the other side of the mid-vein, and so that the portion of the mine each side of the mid-vein is equiangular to the mid-vein. An area of callous tissue forms on the mid-vein. Two short lateral channels are also mined, one on each side of the mid-vein.

Oval cases in which the larvae pupate are cut from the distal end of the mine, and are lined with silk. Up to 3 mines may occur on one leaf. Pupal cases are cream with a pale brownish suffusion.

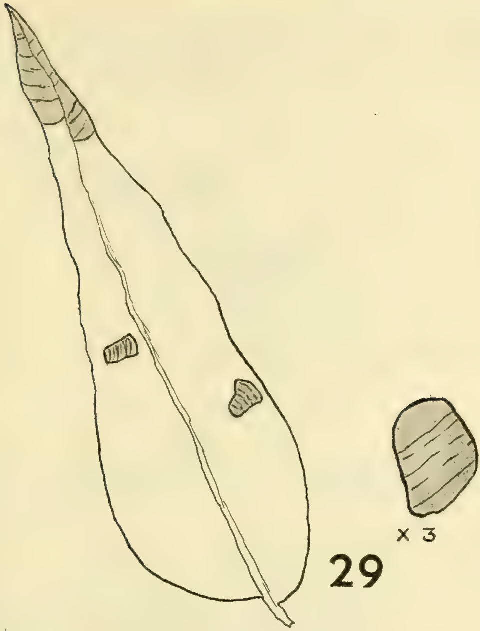


Figure 29. Mine of *"Tinea"* sp. on *Eucalyptus saligna.*

D. Family Incurvariidae.

"Tinea" sp. (in *spodina* group.)

Mine type: Blotch (Figure 29).

Host: *E. saligna.*

Locality: Ourimbah State Forest; Lisarow; Gosford, N.S.Wales.

Notes: Larvae collected during August and September emerged during the following March. Larvae are cream in colour and pupal cases are dark brown, almost rectangular in shape, with fine, dark transverse striations.

The position of the mine on the leaf is variable, and often the tissues of the tip of the leaf are mined. More than one mine may occur on the one leaf. The shape of the dark brown blotch area is usually oblong to square, with distinctive darker fine transverse lines. The mined area is filled with larval excreta around the perimeter, and an area of deep purplish staining occurs around the edges.

Figure 30. Mine of *"Tinea"* sp. on *Eucalyptus acmenioides.*

"Tinea" sp. (near *spodina.*)

Mine type: Blotch (Figure 30).

Hosts: *E. acmenioides; E. saligna; E. pilularis.*

Locality: Lisarow, N.S.Wales.

Notes: Oviposition occurs below the cuticle of the leaf. Larvae are cream in colour, with the segments flattened laterally; the head is brown and retractile into the prothoracic segment to the base of the mandibles. They have been collected during June to early September, and those collected during June and July emerged as adults during the following March, so that a lengthy larval diapause occurs in the pupal case. Pupal exuviae are protruded from the cases as the adults emerge.

Position of the mine on a leaf is variable, and there are often several mines on one leaf. The outer edges of the mine are translucent, with particles of excreta clearly visible. The centre of the mined area, which later constitutes the case in which the larva pupates, is at first filled with excreta and later covered with silk. This area is dark brown, and the outer edges of the mine are surrounded with an area of reddish-purple staining.

Chalcidoid parasites which emerged by way of a small circular hole cut in the centre of the pupal case, were reared during May.

"Tinea" sp. (near *pentaspila* Meyrick.)

Mine type: Blotch (Figure 31).

Hosts: *Eucalyptus sieberi* L. Johnson.

Locality: Blackheath, N.S.Wales.

Notes: Position of the mine on a leaf is variable, and more than one may occur on the same leaf. Mines are at first red-brown, then dark grey-brown in a later stage of construction. The early mine is filled with

excreta, while in the later portion it is scattered throughout the translucent area. A more or less oval to pear-shaped pupal case is cut out from the translucent part, and is shed from the leaf. Cases are about 5.5 mm. in length and 3 mm. wide, grey-brown and lined with silk. A purple stain occurs along the edge of the mine, and extends outward along the leaf venation.

31

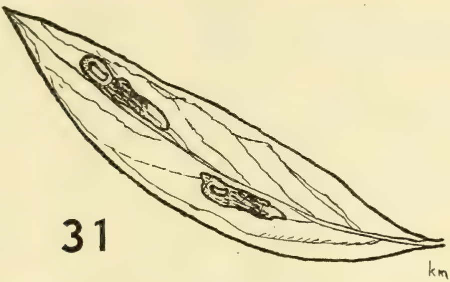


Figure 31. Mine of *"Tinea"* sp. on *Eucalyptus sieberi.*

"Tinea" sp.

Newman & Clark (1945) record that hosts of this Western Australian species are *E. marginata* Donn ex Sm; *E. rudis* Endl.; and the species is accidental to *E. gomphocephala* A.DC., *E. salubris* F. Muell. and *E. transcontinentalis* Maiden.

E. Family Tineidae.

"Tinea" nectarea Meyrick.

Mine type: Blotch (Figure 32).

Hosts: *E. acmenioides; E. pilularis; E. saligna.*

Localities: Lisarow; Sydney; Lawson, N.S.Wales.

Notes: Larvae of this species pull around with them a case which serves as their shelter when they are not mining. They have been collected during August to April.

Prior to construction of the first case, two leaves of the host plant are held together with strands of silk between which the larvae feed and from which they extrude their excreta. The first case is cut from these two leaves and larvae then move to a new leaf to which the case is attached by strong strands of silk. Larvae then commence mining from the point of attachment to the leaf. The point of attachment is later indicated by a small round hole in the leaf cuticle through which the larvae mine the parenchyma between the leaf cuticles, so that the mines appear translucent. Although larvae usually attach their cases to the ventral leaf surface, some may feed from the dorsal surface. While mining, larvae often leave the case to extend the mine beyond their own length, but always return to the case to void excreta through the posterior end of the case. The cases, later formed from the upper and lower cuticles of the one leaf, are pale fawn, with a raised median ridge on each side from the anterior to the posterior exits. Cases constructed by last instar larvae are up to 10 mm. long and 10 mm. wide. The portion of the upper leaf cuticle surrounding the mine may be partly or wholly stained with

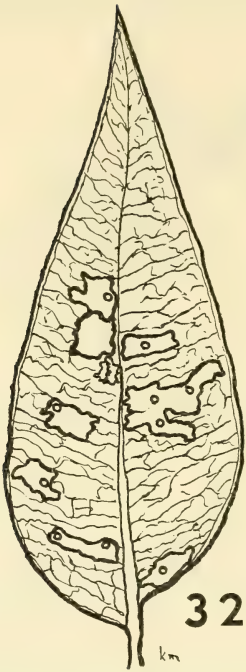


Figure 32. Mine of *"Tinea" nectarea* on *Eucalyptus saligna.*

purple, but this does not occur on the lower leaf cuticle. The round entrance hole to the mine is about 1.5 mm. in diameter.

Last instar larvae may move to the stem of the leaf, or to the twig, to attach their cases with a circular pad of silk, in which they pupate.

There appear to be two or three generations of this species each year, adults emerging three weeks after pupation during November, December, February or May. The pupal exuviae is protruded from the lower end of the case, and recently emerged adults cling to the pupal exuviae while their wings expand and dry.

F. Family Glyphipterygidae.

Eupselia sp. (near *carpocapsella* Walker.)

Mine type: Linear (Figure 33).

Hosts: *E. saligna; E. acmenioides.*

Locality: Lisarow, N.S.Wales.

Notes: Larvae have been collected during June to September, and those found during July were in mines half constructed. When the mine is completed, larvae leave it to feed externally during the last instar when jagged-edged holes are eaten in the leaf. Last instar larvae are about 15 mm. in length.

Mining commences near the mid-vein and extends towards the edge of the leaf along the secondary venation. The early portion of the mine is dark brown, and the later portions are pale brown. All of the parenchyma is destroyed and excreta are voided from the mine through a round hole at the proximal end of the mine. There may be 3 holes in the length of the mine. After leaving the mine and feeding externally, the larva constructs a tube on the surface of the leaf with leaf fragments attached to the leaf cuticle, in which the larva shelters while not feeding. The open-ended tube is completed in about 3 days.

Larvae pupate externally on the leaf surface, a pupa being attached to a pad of silk by its cremaster.

33

Figure 33. Mine of *Eupselia* sp. and area of damage on leaf of *Eucalyptus acmenioides.*

34

Figure 34. Mine of *Epiphthora* sp. on *Lomandra longifolia.*

G. Family Gelechiidae.

Epiphthora sp. (=*Apatetris* of Meyrick.)

Mine type: Linear (Figure 34).

Host: *Lomandra longifolia* Labill.

Locality: Lisarow, N.S.Wales.

Notes: Larvae collected during September emerged as adults during October and November. Larvae are dark brown, and leave the mine to pupate in the soil in silken cocoons.

Epiphthora sp.

Mine type: Linear.

Host: *Dianella caerulea* Sims.

Locality: Lisarow, N.S.Wales.

Notes: Larvae collected during September emerged as adults during October and November. Oviposition occurs on the central leaf vein on the upper surface, or near the edge of the leaf on the lower surface. The mines are similar in appearance to those of the previous species. Larvae are distinctive, with 4 broad dark transverse bands separated by broad pale bands. Pupation occurs in the soil. At least two generations occur each year, larvae also being present during January and February.

Gnoremoschema operculella (Zell.).

This species, commonly known as the "potato moth" attacking *Solanum tuberosum* L. is well known, and the N.S.W. Department of Agriculture has published information in Insect Pest Leaflet No. 90.

Gnoremoschema phasiosema (Turner).

Larvae of this species are reported as damaging stems of *Lycopersicum esculentum* Mill., as well as the leaves of older plants (N.S.W. Agricultural Gazette, Feb. 1954, pp. 105-6).

H. Family Cosmopterygidae.

Gen. et sp. indet.

Mine type: Linear.

Host: *Gahnia melanocarpa* R.Br.

Locality: Lisarow, N.S.Wales.

Notes: Larvae were collected during September and emerged as adults during October. They bear a narrow dark longitudinal stripe for most of their length, each side of the median area. They attach themselves to the leaves or other support with a thread of silk, and always pupate while lying in a horizontal position.

J. Family Lyonetiidae.

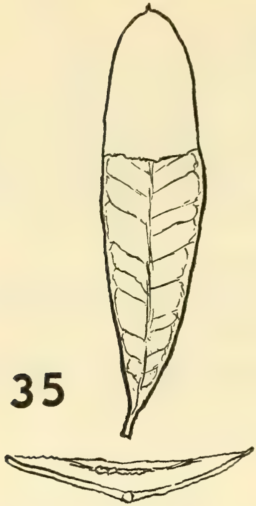
Stegommata sulphuratella Meyrick

Mine type: Blotch (Figure 35).

Host: *Banksia integrifolia.*

Locality: Boat Harbour (Central Coast), N.S.Wales.

Notes: Larvae have been collected during April They are greenish-white in colour, and are suspended inside the mine on the upper leaf cuticle by silken threads, to pupate. A brownish blotch mine is formed at the distal tip of a leaf to about half of its length. The base of the floor of the mine is slightly concave and the upper cuticle forming the "roof" of the mine is horizontal.



35

Figure 35. Mine of *Stegommata sulphuratella* on *Banksia integrifolia,* and section showing suspended pupa.

K. Family Tortricidae.

Peraglyphis atimana (Meyrick).

Larvae of this species mine in the leaves of *Grevillea robusta* A. Cunn. ex R.Br., and have been collected during January and February at Sydney.

Most of the Lepidopterous mines studied are held between celluloid sheets, in the collection of the Forestry Commission of New South Wales.

COLEOPTERA.

A. Family Curculionidae.

Larvae of *Cydmaea diversa* Lea, *C. eucalypti* Lea and *C. luctuosa* Pascoe, have been reported as mining in the foliage of *Hakea teretifolia, H. sericea* and *H. teretifolia* respectively (Moore 1964).

B. Family Chrysomelidae.

Halticorcus platycerii Lea.

This species was reared during September from mines occurring in leaves of the indigenous *Platycerium grande* (Fée) J.Sm. ex Presl. (staghorn) occurring at Lisarow, N.S.Wales. Some biology of the species is given in the N.S.W. Department of Agriculture Insect Pest Leaflet No. 62.

DIPTERA.

Family Agromyzidae.

Japanagromyza eucalypti Spencer.

Mine type: Linear-blotch.

Host: *E. camaldulensis* Dehn. (Specimen planted from nursery stock).

Locality: Lisarow, N.S.Wales.

Notes: This species was first reared from very young foliage of a host plant which had been transplanted from the Narrandera (N.S.Wales) nursery of the Forestry Commission of N.S.W., to Lisarow. A larva collected on 6th February, pupated on 7th, the adult emerging on 23rd February. Wasp parasites emerging during February were also reared from larvae.

This species is the first true agromyzid recorded as feeding on any species of *Eucalyptus* (Spencer 1963:309).

Melanagromyza atomella (Malloch).

Mine type: Linear (Figure 36).

Hosts: *Angophora floribunda; Hydrangea macrophylla* Ser.

Locality: Lisarow, N.S.Wales.

Notes: An extensive list of hosts is given by Spencer (1963). The silver-coloured mine of the specimen reared from *A. floribunda* is reproduced in Figure 36. Larvae were collected, and emerged as adults, during October. They pupate at the distal extremity of the mine and adults emerge through the upper cuticle of the leaf.

Melanagromyza phaseoli (Tryon).

This species is the common pest of cultivated beans, and some of its biology is recorded by Spencer (1963).

Ophiomyia lantanae (Froggatt).

Although this species is not a leaf-miner, it is included here because of its association with the forestry problem of the control of *Lantana camara* L. on State Forests in N.S.Wales.

O. lantanae is common in coastal N.S.Wales, at least as far south as Sydney, where numerous fruits of *L. camara* are attacked. Contrary to Spencer's comment (1963:324) it has been found to attack the seed within the fleshy fruit, as well as mining in the flesh surrounding the seed, so that the reproductive potential of the seed may be destroyed. Some plants have been damaged to such an extent that almost every seed has been destroyed, although control of the host plant in N.S.Wales by *O. lantanae* is ineffectual.

Calicomyza humeralis (U.R.).

Mine type: Blotch.

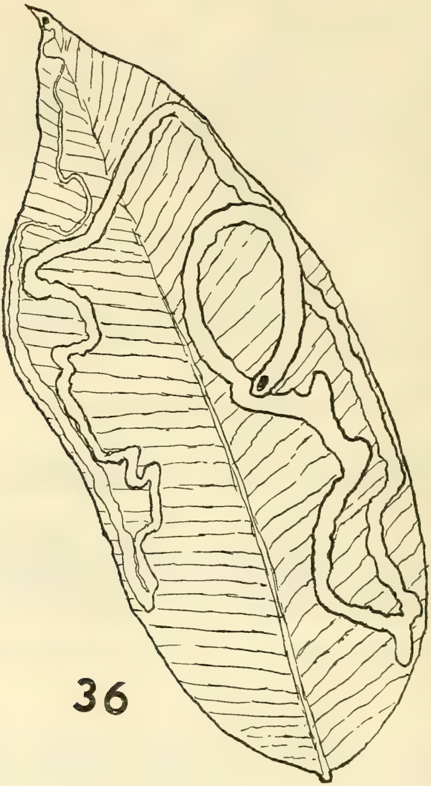
Host: *Erigeron bonariensis* L.

Locality: Sydney, N.S.Wales.

Notes: Adults of this species have been reared from mines on the host plant growing in Sydney streets during January and February. The white mines in the foliage may occur anywhere on the upper leaf surface, and several mines may occur on the one leaf. More than 60 mines have been counted on the one small plant, and mines may be 5 mm. in width and up to 18 mm. in length.

A small brown or black spot on the cuticle of the leaf above the mine indicates the pupation site of the larva within the mine.

A number of indigenous Agromyzidae not reared by the writer, are given by Spencer (1963), and are listed in the appendix to this paper. Introduced species are given by Spencer (pp. 306-7).



36

Figure 36. Mine of *Melanagromyza atomella* on *Angophora floribunda*.

HYMENOPTERA.

Family Argidae.

Schizocerella pilicornis (Holmgren).

Benson (1963) refers to this species as mining in *Portulaca oleracea* L., and as a species introduced from America.

Family Tenthredinidae.

Phylacteophaga froggatti Riek.

Considerable damage to several hosts utilised as amenity plantings, and some of the insect's biology, have been recorded by Hadlington (1954). Hosts mentioned are:— *E. maculata* Hook.; *E. citriodora* Hook.; *E. botryoides* Sm.; *E. robusta; E. sideroxylon* (A. Cunn.) Benth. partim; *E. globulus* Labill.; *E. ficifolia* F. Muell.; *E. cladocalyx* F. Muell. Specimens have been collected from Sydney, Scone and Tamworth, N.S.Wales. Pupation occurs within the mine.

P. froggatti var.

Mine type: Blotch.

Host: *E. saligna.*

Locality: Lisarow, N.S.Wales.

Notes: Mines of this variety appear to be the same as those of *P. froggatti,* and it has been observed that attack is confined to coppice, regeneration and young stock up to about 10 ft. in height.

Larvae were collected during July to January, and up to 6 mines may occur on the one leaf. A purplish staining on the upper leaf cuticle occurs around the proximal narrow portion of the mine where oviposition occurs. Blisters formed by mining larvae are dark brown in colour, and always occur on the upper leaf surface.

Parasites reared from specimens include *Bracon* sp. (Braconidae) and a species of chalcidoid, which is often numerous and exerts considerable control of some populations.

APPENDIX.

Leaf-miner Association with Host species.

Leaf-miner Species	Host-plant Species
ORDER COLEOPTERA	
Family Chrysomelidae	
Halticorcus platycerii	*Platycerium grande*
Family Curculionidae	
Cydmaea diversa	*Hakea teretifolia*
C. eucalypti	*H. sericea*
C. luctuosa	*H. teretifolia*
ORDER DIPTERA	
Family Agromyzidae	
Agromyza testacea	?
? *Agromyza* sp.	*Oplismenus compositus*
Calicomyza humeralis	*Erigeron bonariensis*
Cerodontha australis	?
C. robusta	?
C. vittigera	?
Japanagromyza eucalypti	*Eucalyptus camaldulensis*
? *Liriomyza* sp.	*Billardiera scandens*
L. australina	?
L. brassicae	*Tropaeolum major*
	Gynandropsis speciosa
	Raphanus raphanistrum
	Diplotaxis muralis
	CRUCIFERAE
	CAPPARIDACEAE
L. caulophaga	?
L. chenopodii	*Beta vulgaris*
	Spinacia oleracea
	Stellaris media
	Wallflower
L. helichrysi	*Helichrysum bracteatum*
L. obscurata	?
L. pallidicentralis	?
L. singularis	?
L. tricolor	?
Melanagromyza albisquama	?
M. alternata	?
M. alysicarpi	*Alysicarpus vaginalis*
	A. nummularifolius
M. apii	*Apium graveolens*
	Celery (cultivated)
M. atomella	*Angophora floribunda*
	Barringtonia gracilis
	Celastrus subspicatus
	Doryphora sassafras
	Hydrangea macrophylla
	Marsdenia rostrata
	Passiflora suberosa
	Stephania japonica
	Tylophora barbata
	(see also Spencer 1963)
M. bowralensis	?
M. cassiae	*Cassia bicapsularis*
	? *Erythrina* sp.
M. centrosematis	*Centrosema pubescens*
	Glycine soja

M. conspicua	COMPOSITAE
M. dianellae	*Dianella caerulea*
	Eustephus sp.
M. indigopherae	*Indigophera australis*
	I. suffruticosa
M. metallica	? COMPOSITAE
M. murrayae	*Murraya paniculata*
M. paramonovi	?
M. phaseoli	*Phaseolus lathyroides*
	Cajanus sp.
	Crotalaria sp.
	Dolichos sp.
	Soja sp.
	Vigna sp.
M. piliseta	?
M. pisi	*Pisum sativum*
M. placida	?
M. seneciophila	*Senecio vagus*
M. sojae	LEGUMINOSAE
	Cajanus sp.
	Glycine sp.
	Phaseolus sp.
	Swainsona galegifolia
M. specifica	?
M. trispina	?
M. verdescens	?
M. wilkstroemiae	*Wilkstroemia indica*
	Pimelea ligustrina
Melanagromyza sp.	*Desmodium polycarpum*
	Senecio pterophorus
Ophiomyia angustilunula	?
O. australis	?
O. goodeniae	*Goodenia ovata*
O. lantanae	*Lantana camara*
O. micra	?
O. solanicola	*Solanum prinophyllum*
Pseudonapomyza spicata	*Brachiaria miliformis*
	Elusine indica
	Zea sp.
	GRAMINEAE
Phytobia caliginosa	?
P. humeralis	*Aster subulatus*
	Aster sp.
	Erigeron bonariensis
P. incerta	?
P. poemyzina	? CYPERACEAE
P. triplicata	? *Juncus* sp.
Phytoliriomyza australiensis	?
Phytomyza atricornis	*Bidens pilosa*
	Chrysanthemum maximum
	Cirsium vulgare
	Coreopsis sp.
	Helichrysum rutidolepis
	Senecio dryadeus
	S. lautus
	S. linearifolius
	S. minimus
	S. pterophorus
	Sonchus oleraceus
P. clematidicolla	*Clematis aristata*
P. plantaginis	*Plantago* spp.

P. vitalbae	*Clematis aristata*
	C. montana
?	*Cassinia aculeata*
?	*C. aureonitens*
	Helichrysum dendroideum
?	*Goodenia ovata*
	Senecio sp.

ORDER HYMENOPTERA

Family Argidae

Schizocerella pilicornis	*Portulaca oleracea*

Family Tenthredinidae

Phylacteophaga froggatti	*Eucalyptus botryoides*
	E. citriodora
	E. cladocalyx
	E. ficifolia
	E. globulus
	E. maculata
	E. robusta
	E. sideroxylon
P. froggatti var.	*E. saligna*

ORDER LEPIDOPTERA

Family Cosmopterygidae

?	*Gahnia melanocarpa*

Family Gelechiidae

Epiphthora sp.	*Lomandra longifolia*
Epiphthora sp.	*Dianella caerulia*
Gnoremoschema operculella	*Solanum tuberosum*
G. phaseosema	*Lycopersicum esculentum*

Family Glyphipterygidae

Eupselia sp. nr. *carpocapsella*	*E. acmenioides*
	E. saligna

Family Gracilariidae

Acrocercops calicella	*Eucalyptus acmenioides*
A. chionosema	*Macadamia alternifolia*
A. hoplocala	*E. saligna*
A. laciniella	*Angophora costata*
	A. floribunda
	E. acmenioides
	E. pilularis
	E. saligna
A. macaria	*Euodia micrococca*
A. ordinatella	*Cinnamonum camphora*
A. plebeia	*Acacia podalyrifolia*
A. nr. *argyrodesma*	*Hakea salicifolia*
Acrocercops sp. nov. ?	*E. radiata*
Acrocercops sp.	*Asterolasia correifolia*
Acrocercops sp.	*Pomaderris ligustrina*
Gracilaria xanthopharella	*Glochidion ferdinandi*
Parectopa ida	*Angophora floribunda*
	E. acmenioides
	E. gummifera
	E. paniculata
	E. pilularis
	E. robusta
	E. saligna
Phyllocnistis diaugella	*Breynia oblongifolia*
Phyllocnistis sp. nov. ?	*Hibbertia scandens*

Family Heliozelidae

Heliozela prodela	*Angophora floribunda*
	E. acmenioides
	E. gummifera
	E. pilularis
	E. saligna
Heliozela sp. ?	*E. acmenioides*
	E. grandis
	E. saligna
Heliozela sp. ?	*Angophora floribunda*
	E. pilularis
Heliozela sp. ?	*E. stricta*

Family Incurvariidae

"Tinea" sp. (*spodina* group)	*E. saligna*
"Tinea" sp. nr. *pentaspila*	*E. acmenioides*
	E. pilularis
	E. saligna
"Tinea" sp. nr. *pentaspila*	*E. sieberi*
"Tinea" nectarea	*E. acmenioides*
	E. pilularis
	E. saligna

Family Lyonetiidae

Stegommata sulphuratella	*Banksia integrifolia*

Family Nepticulidae

Nepticula phyllanthina	*Glochidion ferdinandi*
Nepticula funeralis ?	*E. acmenioides*
	E. pilularis
Nepticula sp. (*funeralis group*)	*E. grandis*
	E. microcorys
	E. saligna
Nepticula sp. No. 1.	*Angophora floribunda*
	E. acmenioides
	E. grandis
	E. saligna
Nepticula sp. No. 2.	*A. floribunda*
	E. acmenioides
	E. pilularis
	E. saligna
Nepticula sp. No. 3.	*E. acmenioides*
	E. pilularis
	E. saligna
Nepticula sp. No. 4.	*E. acmenioides*
	E. microcorys
	E. pilularis
	E. saligna
Nepticula sp. No. 5.	*E. acmenioides*
	E. pilularis
Nepticula sp.	*Asterolasia correifolia*
Nepticula sp.	*Pomaderris ligustrina*
Nepticula sp.	*E. acmenioides*
Nepticula sp.	*E. acmenioides*
	E. microcorys
	E. saligna
Nepticula sp.	*Angophora floribunda*
Nepticula sp.	*Rubus moorei*
Nepticula sp.	*Banksia serrata*
Nepticula sp.	*B. integrifolia*

Family Tortricidae

Peraglyphis atimana	*Grevillea robusta*

HOST AND LEAF-MINER ASSOCIATIONS

Host	Leaf-miner species	Order	Family
Acacia podalyriifolia	*Acrocercops plebeia*	Lepidoptera	Gracilariidae
Alysicarpus nummularifolius	*Melanagromyza alysicarpi*	Diptera	Agromyzidae
A. vaginalis	*Melanagromyza alysicarpi*	Diptera	Agromyzidae
Angophora costata	*Acrocercops laciniella*	Lepidoptera	Gracilariidae
A. floribunda	*Melanagromyza atomella*	Diptera	Agromyzidae
A. floribunda	*Acrocercops laciniella*	Lepidoptera	Gracilariidae
A. floribunda	*Parectopa ida*	Lepidoptera	Gracilariidae
A. floribunda	*Nepticula* sp. No. 1	Lepidoptera	Nepticulidae
A. floribunda	*Nepticula* sp. No. 2	Lepidoptera	Nepticulidae
A. floribunda	? sp.	Lepidoptera	Nepticulidae
A. floribunda	*Heliozela prodela*	Lepidoptera	Heliozelidae
A. floribunda	?	Lepidoptera	Heliozelidae
Apium graveolens	*Melanagromyza apii*	Diptera	Agromyzidae
Aster sp.	*Phytobia humeralis*	Diptera	Agromyzidae
Aster subulatus	*Phytobia humeralis*	Diptera	Agromyzidae
Asterolasia correifolia	*Nepticula* sp.	Lepidoptera	Nepticulidae
Asterolasia correifolia	*Acrocercops* sp.	Lepidoptera	Gracilariidae
Banksia integrifolia	*Stegommata sulphuratella*	Lepidoptera	Lyonetiidae
B. serrata	?	Lepidoptera	Nepticulidae
Barringtonia gracilis	*Melanagromyza atomella*	Diptera	Agromyzidae
Beta vulgaris	*Liriomyza chenopodii*	Diptera	Agromyzidae
Bidens pilosa	*Phytomyza atricornis*	Diptera	Agromyzidae
Billardiera scandens	*Liriomyza* sp.	Diptera	Agromyzidae
Brachiaria miliformis	*Pseudonapomyza spicata*	Diptera	Agromyzidae
Breynia oblongifolia	*Phyllocnistis diaugella*	Lepidoptera	Gracilariidae
Cajanus sp.	*Melanagromyza phaseoli*	Diptera	Agromyzidae
CAPPARIDACEAE	*Lyriomyza brassicae*	Diptera	Agromyzidae
Cassia bicapsularis	*Melanagromyza cassiae*	Diptera	Agromyzidae
Cassinia aculeata	?	Diptera	Agromyzidae
C. aureonitens	?	Diptera	Agromyzidae
Celastrus subspicatus	*Melanagromyza atomella*	Diptera	Agromyzidae
Centrosema pubescens	*M. centrosematis*	Diptera	Agromyzidae
Chrysanthemum maximum	*Phytomyza atricornis*	Diptera	Agromyzidae
Cinnamomum camphora	*Acrocercops ordinatella*	Lepidoptera	Gracilariidae
Cirsium vulgare	*Phytomyza atricornis*	Diptera	Agromyzidae
Clematis aristata	*P. clematidicollis*	Diptera	Agromyzidae
C. montana	*P. vitalbae*	Diptera	Agromyzidae
COMPOSITAE	*Melanagromyza conspicua*	Diptera	Agromyzidae
do. ?	*M. metallica*	Diptera	Agromyzidae
Coreopsis sp.	*Phytomyza atricornis*	Diptera	Agromyzidae
Crotalaria sp.	*Melanagromyza phaseoli*	Diptera	Agromyzidae
CRUCIFERAE	*Liriomyza brassicae*	Diptera	Agromyzidae
CYPERACEAE ?	*Phytobia poemyzina*	Diptera	Agromyzidae
Desmodium polycarpum	*? Melanagromyza* sp.	Diptera	Agromyzidae
Dianella caerulea	*Melanagromyza dianellae*	Diptera	Agromyzidae
	Epiphthora sp.	Lepidoptera	Gelechiidae
Diplotaxis muralis	*Liriomyza brassicae*	Diptera	Agromyzidae
Dolichos sp.	*Melanagromyza phaseoli*	Diptera	Agromyzidae
Doryphora sassafras	*M. atomella*	Diptera	Agromyzidae
Eleusine indica	*Pseudonapomyza spicata*	Diptera	Agromyzidae
Erigeron bonariensis	*Calicomyza humeralis*	Diptera	Agromyzidae
	Phytobia humeralis	Diptera	Agromyzidae
Erythrina sp. ?	*Melanagromyza cassiae*	Diptera	Agromyzidae
Eucalyptus acmenioides	*Acrocercops calicella*	Lepidoptera	Gracilariidae
	A. laciniella	Lepidoptera	Gracilariidae
	Parectopa ida	Lepidoptera	Gracilariidae
	Nepticula ? funeralis	Lepidoptera	Nepticulidae
	Nepticula sp. No. 1	Lepidoptera	Nepticulidae

	Nepticula sp. No. 2	Lepidoptera	Nepticulidae
	Nepticula sp. No. 3	Lepidoptera	Nepticulidae
	Nepticula sp. No. 4	Lepidoptera	Nepticulidae
	Nepticula sp. No. 5	Lepidoptera	Nepticulidae
	?	Lepidoptera	Nepticulidae
	Heliozela prodela	Lepidoptera	Heliozelidae
	?	Lepidoptera	Heliozelidae
	"*Tinea*" sp. nr. *spodina*	Lepidoptera	Incurvariidae
	"*Tinea*" *nectarea*	Lepidoptera	?
	Eupselia nr. *carpocapsella*	Lepidoptera	Glyphipterygidae
Eucalyptus botryoides	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
E. camaldulensis	*Japanagromyza eucalypti*	Diptera	Agromyzidae
E. citriodora	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
E. cladocalyx	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
E. ficifolia	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
E. globulus	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
E. grandis	*Nepticula* sp. (*funeralis* group)	Lepidoptera	Nepticulidae
E. grandis	*Nepticula* sp. No. 1	Lepidoptera	Nepticulidae
E. grandis	?	Lepidoptera	Heliozelidae
E. gummifera	*Parectopa ida*	Lepidoptera	Gracilariidae
	Heliozela prodela	Lepidoptera	Heliozelidae
E. maculata	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
E. microcorys	*Nepticula* sp. (*funeralis* group)	Lepidoptera	Nepticulidae
	Nepticula sp. No. 4	Lepidoptera	Nepticulidae
	?	Lepidoptera	Nepticulidae
E. paniculata	*Parectopa ida*	Lepidoptera	Gracilariidae
E. pilularis	*Acrocercops laciniella*	Lepidoptera	Gracilariidae
	Parectopa ida	Lepidoptera	Gracilariidae
	Nepticula funeralis ?	Lepidoptera	Nepticulidae
	Nepticula sp. No. 2	Lepidoptera	Nepticulidae
	Nepticula sp. No. 3	Lepidoptera	Nepticulidae
	Nepticula sp. No. 4	Lepidoptera	Nepticulidae
	Nepticula sp. No. 5	Lepidoptera	Nepticulidae
	Heliozela prodela	Lepidoptera	Heliozelidae
	?	Lepidoptera	Heliozelidae
	"*Tinea*" sp. nr. *spodina*	Lepidoptera	Incurvariidae
	"*Tinea*" *nectarea*	Lepidoptera	Tineidae
E. radiata	*Acrocercops* sp. nov ?	Lepidoptera	Gracilariidae
E. robusta	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
	Parectopa ida	Lepidoptera	Gracilariidae
E. saligna	*Phylacteophaga froggatti* var.	Hymenoptera	Tenthredinidae
	Acrocercops hoplocala	Lepidoptera	Gracilariidae
	A. laciniella	Lepidoptera	Gracilariidae
	Parectopa ida	Lepidoptera	Gracilariidae
	Nepticula sp. (*funeralis* group)	Lepidoptera	Nepticulidae
	Nepticula sp. No. 1	Lepidoptera	Nepticulidae
	Nepticula sp. No. 2	Lepidoptera	Nepticulidae
	Nepticula sp. No. 3	Lepidoptera	Nepticulidae
	Nepticula sp. No. 4	Lepidoptera	Nepticulidae
	?	Lepidoptera	Nepticulidae
	Heliozela prodela	Lepidoptera	Heliozelidae
	?	Lepidoptera	Heliozelidae
	"*Tinea*" in *spodina* group	Lepidoptera	Incurvariidae
	"*Tinea*" nr. *spodina*	Lepidoptera	Incurvariidae
	"*Tinea*" *nectarea*	Lepidoptera	Tineidae
	Eupselia nr. *carpocapsella*	Lepidoptera	Glyphipterygidae
E. sideroxylon	*Phylacteophaga froggatti*	Hymenoptera	Tenthredinidae
E. sieberi	"*Tinea*" nr. *pentaspila*	Lepidoptera	Incurvariidae
E. stricta	?	Lepidoptera	Heliozelidae
Euodia micrococca	*Acrocercops macaria*	Lepidoptera	Gracilariidae
Eustephus sp.	*Melanagromyza dianellae*	Diptera	Agromyzidae
Gahnia melanocarpa	?	Lepidoptera	Cosmopterygidae

Glochidion ferdinandi	*Gracilaria xanthopharella*	Lepidoptera	Gracilariidae
	Nepticula phyllanthina	Lepidoptera	Nepticulidae
Glycine sp.	*Melanagromyza sojae*	Diptera	Agromyzidae
G. soja	*M. centrosematis*	Diptera	Agromyzidae
Goodenia ovata	*Ophiomyia goodeniae*	Diptera	Agromyzidae
GRAMINEAE	*Pseudonapomyza spicata*	Diptera	Agromyzidae
Grevillea robusta	*Peraglyphis atimana*	Lepidoptera	Tortricidae
Gynandropsis speciosa	*Liriomyza brassicae*	Diptera	Agromyzidae
Hakea salicifolia	*Acrocercops* nr. *argyrodesma*	Lepidoptera	Gracilariidae
H. sericea	*Cydmaea eucalypti*	Coleoptera	Curculionidae
H. teretifolia	*C. diversa*	Coleoptera	Curculionidae
	C. luctuosa	Coleoptera	Curculionidae
Helichrysum bracteatum	*Liriomyza helichrysi*	Diptera	Agromyzidae
H. dendroideum	?	Diptera	Agromyzidae
H. rutidolepis	*Phytomyza atricornis*	Diptera	Agromyzidae
Hibbertia scandens	*Phyllocnistis* sp. nov. ?	Lepidoptera	Gracilariidae
Hydrangea macrophylla	*Melanagromyza atomella*	Diptera	Agromyzidae
Indigophera australis	*M. indigopherae*	Diptera	Agromyzidae
I. suffruticosa	*M. indigopherae*	Diptera	Agromyzidae
Juncus sp. ?	*Phytobia triplicata*	Diptera	Agromyzidae
Lantana camara	*Ophiomyia lantanae*	Diptera	Agromyzidae
LEGUMINOSAE	*Melanagromyza sojae*	Diptera	Agromyzidae
Lomandra longifolia	*Ephiphthora* sp.	Lepidoptera	Gelechiidae
Lycopersicon esculentum	*Gnoremoschema phaesiosema*	Lepidoptera	Gelechiidae
Macadamia integrifolia ?	*Acrocercops chionosema*	Lepidoptera	Gracilariidae
Marsdenia rostrata	*Melanagromyza atomella*	Diptera	Agromyzidae
Murraya paniculata	*M. murrayae*	Diptera	Agromyzidae
Oplismenus compositus	*Agromyza* sp. ?	Diptera	Agromyzidae
Passiflora suberosa	*Melanagromyza atomella*	Diptera	Agromyzidae
Phaseolus sp.	*M. sojae*	Diptera	Agromyzidae
P. lathyroides	*M. phaseoli*	Diptera	Agromyzidae
Pimelea ligustrina	*M. wilkstroemiae*	Diptera	Agromyzidae
Pisum sativum	*M. pisi*	Diptera	Agromyzidae
Plantago sp.	*Phytomyza plantaginis*	Diptera	Agromyzidae
Platycerium grande	*Halticorcus platycerii*	Coleoptera	Chrysomelidae
Pomaderris ligustrina	*Acrocercops* sp.	Lepidoptera	Gracilariidae
	Nepticula sp.	Lepidoptera	Nepticulidae
Portulaca oleracea	*Schizocerella pilicornis*	Hymenoptera	Argidae
Raphanus raphanistrum	*Liriomyza brassicae*	Diptera	Agromyzidae
Rubus moorei	*Nepticula* sp. ?	Lepidoptera	Nepticulidae
Senecio sp.	?	Diptera	Agromyzidae
S. dryadeus	*Phytomyza atricornis*	Diptera	Agromyzidae
S. lautus	*Phytomyza atricornis*	Diptera	Agromyzidae
S. linearifolius	*Phytomyza atricornis*	Diptera	Agromyzidae
S. minimus	*Phytomyza atricornis*	Diptera	Agromyzidae
S. pterophorus	*Phytomyza atricornis*	Diptera	Agromyzidae
S. pterophorus	? *Melanagromyza* sp.	Diptera	Agromyzidae
S. vagus	*Melanagromyza seneciophila*	Diptera	Agromyzidae
Soja sp.	*M. phaseoli*	Diptera	Agromyzidae
Solanum prinophyllum	*Ophiomyia solanicola*	Diptera	Agromyzidae
S. tuberosum	*Gnoremoschema operculella*	Lepidoptera	Gelechiidae
Sonchus oleraceus	*Phytomyza atricornis*	Diptera	Agromyzidae
Spinacia oleracea	*Liriomyza chenopodii*	Diptera	Agromyzidae
Stellaris media	*Liriomyza chenopodii*	Diptera	Agromyzidae
Swainsona galegifolia	*Melanagromyza sojae*	Diptera	Agromyzidae
Tropaeolum major	*Liriomyza brassicae*	Diptera	Agromyzidae
Tylophora barbata	*M. atomella*	Diptera	Agromyzidae
Vigna sp.	*M. phaseoli*	Diptera	Agromyzidae
Wilkstroemia indica	*M. wilkstroemiae*	Diptera	Agromyzidae
Zea sp.	*Pseudonapomyza spicata*	Diptera	Agromyzidae

ACKNOWLEDGEMENTS

The writer is grateful to his colleague Mr. P. Hadlington for his criticism of the manuscript; to Mr. I. F. B. Common, C.S.I.R.O., Canberra, for identifications of most of the Lepidoptera recorded in this paper; to Mr. L. A. S. Johnson, of The Royal Botanic Gardens, Sydney, for the identifications of the botanical material; and to Mrs. J. Fitzell, Forestry Commission of N.S.W. for typing the manuscript.

REFERENCES

Benson, R. B., 1963.—"The Affinities of the Australian Argidae." *Ann. Mag. Nat. Hist.* Ser. 13, 5:631-5.

Cann, H. J., 1965.—"The Macadamia—Australia's Own Nut." *Agric. Gazette of N.S.W.* (February) N.S.W. Govt. Printer.

Freeman, T. N., 1965.—"A Lepidopterous Leaf-mine from the Tertiary Period." *Canad. Ent.* 97 (10): 1069-70 (October).

Froggatt, W. W., 1927.—"The leaf-mining Moth of the Queensland Silver Wattle." *For. Ins. & Timber Borers,* pp. 36-38. N.S.W. Govt. Printer.

Hadlington, P., 1954.—"The Leaf Blister Sawfly." *For. Commn. Tech. Notes,* 8 (1): 16-19. N.S.W. Govt. Printer.

Hering, E. M., 1951.—"Biology of the Leaf-miners." Uitgeverij, W. Junk, 's-Gravenhage.

Moore, K. M., 1963.—"Two species of Lepidopterous Leaf-miners attacking *Eucalyptus pilularis* Smith." *Aust. Zool.* 13 (1): 46-53 (September).

————, 1964.—"Insects attacking *Hakea* spp. in New South Wales." *Proc. Linn. Soc. N.S.W.* 89 (3): 295-306.

Needham, J. G., Frost, S. W. & Tothill, Beatrice H., 1928.—"Leaf-mining Insects." 351 pp. Bailliere, Tindall & Cox, London.

Newman, J. J. & Clark, J., 1945.—"The Jarrah Leaf-miner." *Aust. For. J.* 9: 95-99.

Spencer, K. A., 1963.—"The Australian Agromyzidae." *Rec. Aust. Mus.* 25 (15): 305-354 (July).

Watt, M. N., 1924.—"The Leaf-mining Insects of New Zealand." *Tr. N.Z. Inst.* 55: 674-687. Wellington N.Z. Govt. Printer.

T. J. LEMPRIERE, AN EARLY TASMANIAN NATURALIST

By G. P. Whitley

(Plate XX).

> *"We are in hopes that the fish of Port Arthur have been described at home from specimens of each kind collected by the author for Sir John Franklin and sent home in spirits by His Excellency to the justly celebrated Dr. Richardson."*
>
> *—T. J. Lempriere, Penal Settlements of early Van Diemen's Land, 1954, p. 64.*

The skate, *Raja lemprieri* Richardson, 1845, appears to be the only species of animal named in honour of Thomas James Lempriere (1796-1852) who deserves fuller recognition as a naturalist and part-time scientist in the early days of Tasmania. The following sketch of Lempriere's career hardly does justice to his many-sided nature but may serve as a preliminary outline for future students to fill out and colour.

First a trader, then a military official, Lempriere had a pronounced scientific bent. He carefully recorded weather conditions and was praised by the Governor, Sir John Franklin, for his meteorological observations; he devised chemical experiments; he tried to set up small museums in Hobart and at Port Arthur. He collected fishes for John Richardson and mammals, birds and insects for William Swainson; his correspondence with the latter has been catalogued by Gunther (1900). Lempriere was an accomplished artist who painted portraits of the identities of his period, also views of land and sea. He took quite a time over these paintings, returning to them again and again. He must have written voluminously though few of his manuscripts appear to have survived and only a small amount has been preserved in print. In 1838, he was making drawings for a book (probably autobiographical) he was writing, which never seems to have been published, though he offered it to the editor of the *Tasmanian* for the press.

Lempriere's manuscript journal, or diary, for 1837 to 1838, the original of which is in the Mitchell Library, Sydney, enables us to picture him as a clever, cultivated, convivial, straightforward man. Life in Tasmania in the convict days was eventful, but not perhaps as hectic as today's modern pace. The Sabbath was strictly observed, no work whatever being done. If the weather was too bad, family prayers were held at home. Lempriere himself officiated at the church, even delivering an Easter sermon; in those days it was not necessary to have been ordained. He was very busy on military ration days, but otherwise had enough leisure for riding, walking, hunting, fishing, boating and sailing (though he suffered from seasickness), sketching, and visiting friends (smoked a cigar at Benson's or "took a chop with Mr. Poole"), reading ("amused myself with Pickwick"—so soon after it was published!), or playing games like cribbage, whist, vingt-et-un, loo, draughts, backgammon and chess. He took his bugle into the empty New Church to try the sound, which he described as "grand". He was hospitable to the officers of visiting French ships such as *La Favorite* and the corvette *l'Heroine*. At one ship's party his young son sang a French song and took one glass of wine; his father perhaps took more than one glass since he left his beloved bugle on board. T. J. Lempriere was a horticulturist, grafting fruit-trees, and an apiarist. He taught his children to draw and to sing in French and English. He gave lessons on French history, geography, geometry, etc. and was secretary of the Mechanics' Institution at Hobart. He was, at its inception, a corresponding member of the Tasmanian Society (later the Royal Society of Van Diemen's Land, and of Tasmania). He was a Justice of the Peace and sat on inquests. A portrait, believed to be of him, and bearing his signature, is in the Mitchell Library, Sydney, and is reproduced here as plate XX.

In 1823, he had married a Miss Charlotte Smith who, in the course of a long and happy life, bore him six sons and five daughters.

Thomas James Lempriere was of Norman-Jersey descent and was born at Hamburg on 11 February[1], 1796. His father, Thomas Lempriere, was a London merchant. Hudspeth (1949) tells us that, while a banker on the Continent in 1803, he and his family were taken into custody by order of Napoleon Bonaparte and interned until 1815. In 1825, Thomas, the father, came out to Tasmania and received a grant of 1,000 acres at Mount Direction; he died on 4th January 1829 and was buried in Hobart alongside his wife who had predeceased him.[2]

Coming back to his son, Thomas James Lempriere, Hudspeth continues: "When a mere boy he had an exciting experience. As already stated he was interned on the Continent with his father and family. Under the regulations then in force regarding internees, children of not more than 11 years of age could be released from custody. Although young Thomas was 16 (apparently an error as in 1803 he would have been 7—G.P.W.), he was dressed as a boy of 11, and sent off alone to England, with a Passport which understated his age, and carrying a trunk fitted with a false bottom and sides, in which were concealed Despatches to the Horse Guards and Admiralty, as well as letters to people in England. After an adventurous journey, he succeeded in reaching his destination and in delivering the precious documents." This episode is also referred to in *Men of the Time in Australia* (1878), wherein T. J. Lempriere is referred to as an officer who in the last war with France had after a nine years' experience as a prisoner of war, the honour and satisfaction of participating as lieutenant in the waggon train in the victory of Waterloo.

Thomas James Lempriere lived in England and Europe. In December, 1882 he came to Hobart Town, Tasmania, on the ship *Regalia* and early in 1823 took possession of Mount Pleasant and its vicinity. The *Hobart Town Gazette* of 1823 carries various references to the stores run in Elizabeth Street by Lempriere & Co. Money must have been in short supply, since "Wheat, wool, oil, seal, opossum, kangaroo rat and emu skins, with any article of Colonial produce" were taken in payment for goods, at cash prices, and Spanish dollars were also accepted. A wide range of goods was sold; imported articles, "excellent Irish butter by the firkin", saddlery, horses, boats, drapery, brushes, Epsom salts, timber, books, etc. and warehouse storage was also offered. However, Lempriere's trade ventures were apparently not successful in the long run, and he entered the Commissariat Department. In 1824 and 1825, Mrs. Lempriere conducted a school for girls, helped by Miss Lempriere, her sister-in-law, at Roseway Lodge on New Town Rivulet, Hobart. In 1826, T. J. Lempriere and his wife were at Maria Island where he was in charge of the Commissariat issues. In 1827, Lempriere left for another Tasmanian settlement, Macquarie Harbour (*Hobart Town Gazette,* Nov. 1, 1827). There he offered to collect for William Swainson in England. He had sent two ornithorhynchi. He was appointed Clerk to the Market, Hobart (*Australian* newspaper, Oct. 10, 1828) and was preparing a Universal View of Van Diemen's Land which was intended to be published in England (*Australian,* May 14, 1828 and *Sydney Gazette,* May 16, 1828, p. 3, a). There are references to him, too, in *Hist. Rec. Austr.* (3) iv, pp. 101 & 532, as a settler, storekeeper and a proprietor in the bank of Van Diemen's Land.

---

[1] According to his own manuscript Journal, 1838, p. 117, but other accounts give January as the month.

[2] Thomas Lempriere, T. J. L's. father, was born at Faroun al Carkekin, Port of Portugal, in 1757. He emigrated to Van Diemen's Land from Whitby, England. See *Hobart Town Courier,* 10 Jan. 1829; *Sydney Gazette,* 24 Jan. 1829, p. 2, col. 6, and Hudspeth, 1949, p. 27.

Lempriere's correspondence with Swainson continued from Hobart in 1830 and from Newport in 1831. In 1832, he was secretary to the Mechanics' Institution at Hobart Town. Then according to the journals of George A. Robinson, to which Mr. N. Plomley directed my attention, on March 17, 1833, Lempriere was to relieve Mr. Neill at Port Arthur. He was still there in October 1833 when he promised to draw portraits of Tasmanian aborigines for Robinson. In March and April, 1834, inspired by a copy of Swainson's *Zoology* which a friend had given him, Lempriere began sketching Tasmanian birds as the commencement of a series of drawings, the first being of the native sparrow. He also painted a transparency of his coat of arms at this time[3]. In June 1835 he received a case of entomological instruments from William Swainson and in 1836 Lempriere sent mammals, birds and insects to Swainson from Port Arthur. Another manuscript journal of his, now in the Mitchell Library (MSS., A.577) begins on 1st January 1837, evidently still at Port Arthur, where Lempriere was Deputy Assistant Commissary General. On Aug. 7, 1838, "Got my Military Cloaths", he wrote, and on Sept. 3, 1838, he was gazetted a Justice of the Peace. He made several requests for increased pay and promotion, but these were deferred or slow in coming; the Lieutenant-Governor had allowed him 3/6 per diem for his observations from Port Arthur but this was refused by military headquarters in England. Lempriere seems to have been stationed for years at Port Arthur with occasional trips to Hobart and elsewhere. In 1848, he was relieved by A. C. G. Browne and Lempriere was transferred to Oatlands, Tasmania (*Hobart Town Courier*, July 29 and Oct. 18, 1848). In 1850, he was promoted to Assistant Commissary General. His later career is not known to me, but in 1851 he was ordered from Hong Kong to England for health reasons. He died at Aden on Jan. 5, 1852, aged 56 years, and was buried in the cantonment there with military honours.

His widow, Charlotte Lempriere, died at Bellerive, Tasmania, on Sept. 27, 1890, aged 87 years. Their children were Edward Marsh Lempriere (1824-1847); Charles Monteiro d'Almeida (a surgeon who was attacked by bushrangers); Thomas Henry (1825-191-), who lived over 90 years; James Moodie (1835-59); William George (18-- - ?1887); John Everard Home (died in infancy, 1845); Mary Earle (1829 or 1830 - 1847); Charlotte Sarah Harriet (1833-1885); Lucy Maria (March 31, 1838-1928); Fanny Elizabeth (1840-1923) and Emily (1842-?).

Early Tasmanian Museums

The Australian Museum, Sydney, commenced in 1827, is the oldest museum in Australia, but only just, for Dr. W. Bryden (1963, p. 1), writing from Hobart, stated, "As early as 1828, collections were being made with the thought in mind that when a Museum was actually opened, those collections would rest there. In truth, we should say that a Museum was founded as early as that year . . . ." The Mechanics' Institution of Hobart was founded in 1826. In 1838, "in the new Customs House now in progress, there was a room constructed which was intended for a Museum . . ." Also Dr. John Lhotsky made a collection for a "Franklineum" or museum, probably in 1837, but earlier the Van Diemen's Land Society was announced in the *Tasmanian Almanack,* 1830, p. 63 as having been for the establishment of a Museum and Botanic Garden. The foundation of Lady Franklin's Museum on the Ancanthe estate at Lenah Valley near Hobart was laid on 12th March, 1842. This charming building still stands, though in 1853 the cases and fittings of the Ancanthe Museum were removed to the Royal Society's Museum then situated in Harrington Street, Hobart. Apparently T. J. Lempriere must now be given the credit for establishing a museum (at Port Arthur rather than Hobart?) in 1837.

---

[3] Lempriere papers, 1834-1849 (1), MSS in Mitchell Library, Sydney, A.3343.

In T. J. Lempriere's manuscript journal, as early as the 21st and 22nd April, 1837, the entry occurs (p. 45), "Je me suis occupé à arranger notre future Musée." On May 25th (p. 55): "We go every evening to the Museum. Niercer [?or Mercer, the name is illegible but may have been the Christian name of Lempriere's sister] assists me and we gives them lessons in French History, Geography, Geometry, &c. At 8 we make the observations and come home. By the bye, talking of the Museum, I think I have not noticed that since the first of this Month I have begun keeping meteorological Journals—Internal [?] and attached thermometer, Barometer, Winds, Weather, &c. Dr. Lhotsky's old quarters is the site of the observations and of a museum we are forming." [Dr. John Lhotsky had stayed with Lempriere at Port Arthur from February 18, 1837 to April 16, 1837 and Lempriere took him collecting and used to beat him at chess].

Other references to his museum and his apparatus occur throughout Lempriere's journal, some pages of which are now illegible. A few examples follow:

Page 57. May 31, 1837, ". . . picked up some specimens, found a mineral, can't say what it is. Skinned (very badly) a black cockatoo for museum." Lempriere skinned other birds and mammals and noted when whales were seen in the bay.

Page 62. June 21, 1837: "Was at the Museum all night—after 12 o'clock laid down in my rug between each hour. Edward kept company with me, he did not go to sleep—sent him to his bed at 6 a.m. . . ."

Page 63, June 28, 1837: "for these few days past the Masons have been at work laying the foundations to the increase to our quarters . . . all in dust and confusion."

Page 78. Aug. 31, 1837. "On Monday some rascal stole my thermometer from the Museum. Capt. B.[4] gave the whole of any that were at work there 6 months in the cells unless they produced it—no news of it though."

Pages 101-102. Dec. 10, 1837. "Began arranging specimens on new shelves in the Museum."

Page 104. Dec. 24, 1837. "Mr. Parker killed a fine sword fish—15 feet long—Cart got it. I had hoped to have the head and snout for the Museum but Cart is too greedy." [This is the first record of a swordfish (probably *Xiphias* or perhaps *Istiompax*) from Tasmania. Mr. Cart was Superintendent of Convicts.—G.P.W.]

Page 110. Jan. 13, 1838. Owing to the arrival of an officer, the Museum had to vacate the quarters it occupied. Lempriere removed the specimens and, after dinner on Jan. 15, "laid out the curiosities in the New Museum." A Dr. Everitt called later in January and was give some specimens for himself and some for William Swainson, whom Everitt was going to visit in England; he was also requested to call on Lempriere's relatives at Jersey in the Channel Islands.

Page 116. Feb. 6, 1838: "Arranging shells at the Museum."

Page 120. Feb. 27, 1838: "The Museum being required as quarters for Mr. Brooks had to move the collection to the stores."

Page 123. Feb. 28, 1838: "Took the honey from a fine hive of bees without killing them. Busy setting the New Museum to rights."

---

[4] Captain O'Hara Booth (1800-1851). Lempriere's portrait of the Captain, painted in 1836, is reproduced by Giblin (1926, pl. xi).—G.P.W.

Page 127. Lempriere and others caught snapper and salmon, some of which disagreed with them. [This is the earliest reference to poisoning from eating the fish, *Arripis,* a subject subsequently dealt with by McCoy in 1867. Unfortunately no details are given by Lempriere].

Page 170. August 29, 1838: "Rainy day. Governor [Franklin] inspected stores and museum—appeared pleased—promised to speak to Captain Montague for a salary for Edward—called at our House, was pleased with the Portraits—promised to sit for me. I called on Lady F[ranklin] to see whether she would go round the workships—too wet—gave me some rare seeds . . . ."

Acknowledgements

For information about Lempriere, I am grateful to Mr. P. R. Eldershaw, Archives Officer, State Archives, the State Library of Tasmania, Hobart, and to the librarians of the Mitchell Library and the Australian Museum, Sydney, and the National Library, Kingston, Canberra, A.C.T. Mr. Norman J. B. Plomley, of the University of New South Wales, also kindly supplied references.

Quotations from Lempriere's journal of 1837 and 1838 are from the original unpublished manuscript in the Mitchell Library, Sydney, which has also permitted me to reproduce the pencil portrait ascribed to T. J. Lempriere in its possession.

My thanks are tendered to all concerned.

References to published books and papers.

Bryden, W., 1966.—The Tasmanian Museum and Art Gallery: Historical Note. *Pap. Proc. Roy. Soc. Tas.,* 100, pp. 21-26.

Bryden, W., and others, 1963.—Centenary of the opening of the Tasmanian Museum and Art Gallery Building . . . January—1863, pp. 1-48, pls. i-viii.

Burn, D., 1842.—Excursion to Port Arthur. *Tas. Journ. Nat. Sci.,* 1, pp. 265-295.

Dixson, W., 1921.—*Journ. Roy. Austr. Hist. Soc.,* 7, p. 159.

Giblin, W., 1926.—*Proc. Roy. Soc. Tas.,* 1925 (1926), p. 158, pl. xi.

Gunther, A., 1900.—*Proc. Linn. Soc. Lond.,* 1899-1900, p. 43.

Historical Records of Australia, Series III, vol. 4, publ. 1921, pp. 101 & 532, *et ibid.,* Series III, vol. 5, 1922, p. 331.

Hudspeth, W. H., 1949.—The Story of St. David's Park (Hobart: City Council), 44 pages, illustr. (Lempriere, pp. 27-28).

Lempriere, T. J., 1842a.—Description of a Sea Slug found at Port Arthur. *Tas. Journ. Nat. Sci.,* 1, pp. 152-153.

————, 1842b.—Meteorological Tables taken from the Observations made at Port Arthur from 1st July 1837 to 30th June 1841. *Tas. Journ. Nat. Sci.,* 1, p. 225.

————, 1842-46.—Account of Macquarie Harbour. *Tas. Journ. Nat. Sci.,* 1 (5), 1842, pp. 359-375; 2 (6), 1846, pp. 17-31; 2 (7), 1846, pp. 107-118, and 2 (8), 1846, pp. 200-208.

————, 1846.—Meteorological Observations made at Port Arthur during the Year 1842. *Tas. Journ. Nat. Sci.,* 2, p. 70. [Lempriere here adds early phenological notes: "First swallow seen, 5th Sept. . . . First Bees swarmed, 17th Nov."]

————, 1954.—The penal settlements of early Van Diemen's Land, 112 pp., 1 plate; published by the Launceston branch of the Roy. Soc. Tas.

Men of the Time in Australia, Victorian Series, 1878 (Melbourne: McCarron, Bird), p. 103.

Plomley, N. J. B., 1966.—Friendly Mission: The Tasmanian journals and papers of George Augustus Robinson, 1829-1834 (Hobart: Tas. Hist. Res. Assn.), 1,074 pp.

Richardson, J., 1839-1857.—[Various ichthyological papers, listed by Whitley, 1964, *Proc. Linn. Soc. N.S.Wales,* 89, p, 107. *Raia lemprieri* was named in Zoology of the Voyage of H.M.S. "Erebus" and "Terror" . . . Fishes, 1845, p. 34, pl. xxiii.]

Royal Society of Van Diemen's Land, 1853.—*Report,* 1852, p. [14].

Shaw, A. G. L., 1955.—*Journ. Roy. Austr. Hist. Soc.,* 40 (6), p. 336.

Swainson, W., 1838.—Animals in Menageries, p. 344.

Whitley, G. P., 1933.—*Journ. Roy. Austr. Hist. Soc.,* 19 (5), p. 311.

Whittell, H. M., 1954.—The Literature of Australian Birds, p. 425.

Manuscript Sources.

Backhouse, James.—Journal (Mitchell Library MSS. vol. B.731), under date 27 Nov. 1833, p. 41.

Calder, J. E.—Manuscripts of the 1830's to 1870's in the Calder papers, 1055 pages (Mitchell Library MSS., A.605).

Havard, W. L.—Index (cards in Mitchell Library).

Lempriere, T. J.—Papers, 1834-1849 (Mitchell Library MSS., A.3343; primary sources *5-108A). Include: (1) Diary, partly written in French, Port Arthur, 23 March 1834 to 30 April 1836; (2) Diary, partly in French, Port Arthur and Oatlands, Tas., 1 Feb. 1847 to 11 July 1849; (3) a fair copy, edited for publication, of Lempriere's *Penal Settlements of Van Diemen's Land;* and (4) Document from Sir John Wilmot, 25 May 1846, appointing Lempriere coroner; and Document, dated St. James, 1 June 1846, appointing Lempriere as Acting Commissary General, effective as from 1844.

Lempriere, T. J.—Manuscript diary, written in French and English, from January 1837 to May 1838, 174 pages (Mitchell Library MSS., A.577).

Lempriere Family—Xerox copy of typed list of newspaper references, etc., kindly supplied by Mr. P. R. Eldershaw, State Archives, Hobart.

Robinson, George Augustus—Manuscript journals (Mitchell Library, A.7030, part 7 and A.7031, parts 1-3).

Verreaux, J. P.—Photostat copy of manuscript journal, written in French from 1842 to 1845. Original in Museum d'Histoire naturelle, Paris. Mitchell Library MSS., 580; primary sources *5-132 B., 3 volumes. Ref. to Lempriere, vol. i, p. 41, dated 13 January 1843.

EXPLANATION OF PLATE XX.

Portrait of Thomas James Lempriere, or of an unknown person, by T. J. Lempriere. It could be a self-portrait.

From the original in the Mitchell Library, Sydney.

WILLIAM GALVIN (1787-1873), AN EARLY AUSTRALIAN MUSEUM CUSTODIAN

by G. P. Whitley

Accounts of the early history of the Australian Museum refer to a custodian of the "Colonial Museum" named William Galvin, but no details of his life or services have been published hitherto. Now, as a result of reading, in the Mitchell Library, Sydney, the manuscript *Returns of the Colony of New South Wales* (in the State Archives) from 1822 to 1857, the *Statistical Registers* from 1849 to 1861, and subsequent *Blue Books,* it is possible to place him in his period and establish other particulars. William Galvin was born in 1787.

The *Historical Records of Australia* (Series 1, vols. 15 & 16) list a William Galvin as one of four convict petitioners to Governor Darling for conditional pardon in 1829. They arrived in New South Wales in the ship *Sir Godfrey Webster* in January 1826, having been convicted of manslaughter at Roscommon, Ireland, 9th March 1825, and sentenced to transportation for life. They had been attached to the Police stationed in the town of Athlone when a riot took place and a man was stabbed with a bayonet. It was subsequently held that the blow which occasioned the death for which Galvin and the others had been transported, was inflicted by another man.

According to the *Sydney Gazette,* 7th October 1826, Galvin was sent to a working party for six months. As Galvin's conduct since his arrival in the Colony was held to have been exemplary, he was eventually pardoned (conditionally in 1829 and absolutely in March, 1832). There was also another William Galvin mentioned in the *Sydney Gazette* in 1819 and 1821.

"Our" William Galvin, whosoever he was, was appointed as Messenger, Executive Council, Sydney, on 23 June 1829. On 16 January 1834, he was appointed, by the Governor, in charge of the Colonial Museum at an extra £10 per annum, though a letter [1] from Deas Thomson indicates that he had been in charge since 1831. This infant Australian Museum consisted of a collection of beautifully mounted specimens, particularly birds, prepared by William Holmes the Colonial Zoologist who had died on 24 August 1831, [2] and was housed in rooms which still exist in Parliament House, Macquarie Street, Sydney. A convict, John Roach, was appointed at the same time as Galvin to collect and preserve subjects of Natural History [3].

Galvin's museum services were discontinued on 31st May, 1836, though he continued as Parliamentary Messenger until he retired, due to advanced age, in 1852, when he was 65. He lived long afterwards on a state pension of £35/5/8 per annum, and died on 5th August 1873.

William Galvin was therefore the second custodian of the Australian Museum (Holmes having been the first) and was still in charge of the specimens when the Governor appointed George Bennett Curator on 1 October 1835.

---

1 See *Australian Natural History,* Sept. 1962, p. 100.

2 fide *Return of the Colony* for 1831 (manuscript, unpaged), not in 1830 as stated by Lhotsky and others.

3 Roach was succeeded by W. S. Wall as Collector and Preserver of Specimens, Colonial Museum, on 1 August, 1840—*Return of the Colony of N.S.Wales,* 1840, pp. 118 & 188.

GRACIUS JOSEPH BROINOWSKI: HIS BOOKS AND HIS PROSPECTUSES

by K. A. Hindwood

(Plates XXI-XXIII)

The place of Gracius Joseph Broinowski in Australian art, natural history and ornithology, has been discussed by William Moore (1934), Gregory Mathews (1942), Tom Iredale (1956) and L. Paszkowski (1962). In addition, a summary of his life is given in the *Australian Encyclopaedia* (1958).

Broinowski was born at Wielum in Poland on March 7, 1837, the son of a wealthy landholder in what was then Russian Poland. He was educated at Munich University. Later, to avoid being conscripted into the army, he went to Germany where he was robbed of all his possessions. With a fellow Pole he made his way to London and there taught French for about a year; then, tales of adventure prompted him to ship in a windjammer to Australia.

"The voyage took six months, and every day of it was made a hell for the youth. He was bullied by both officers and crew, who jeered at him because he was foreign. He had no hammock to sleep in, but was given one of the whaleboats hanging on the davits, for a bed. It was a common joke on a winter's morning for an officer to tip the boat, so that the lad would fall on the deck bruised and shivering. However the ship anchored at last in Portland Harbour, Victoria. Broinowski was not allowed to go on shore, but in the early hours of the morning he took french leave of the hated ship and swam to land. He hurried through the town, and into the country, and after some hours walking came to a little house by the road. Here he met with the first act of kindness he had known since he left his home. He asked for a drink of water, and an old Scottish lady asked him in, fed him with the best she had, and sent him on his way with new courage" (Mathews, 1942, p. 196).

Broinowski worked for a few years in the country and then settled in Melbourne, finding employment as a canvasser for a firm of publishers. Later, he travelled widely in Victoria, New South Wales and Queensland painting landscapes and scenes of various towns and promoting "art-unions," with his pictures as prizes.

In either 1879 or 1880 he settled in Sydney where he taught painting to private pupils and at colleges, lectured on art and exhibited at various showings of the Royal Art Society, of which body he was an active member. His first commercial venture into the field of natural history seems to have been a commission to supply the Department of Public Instruction of New South Wales with pictures of the birds and mammals of Australia. These illustrations were coloured lithographs mounted on boards and varnished, and were hung in classrooms throughout the State. The project was commenced in the early 1880's and, during the next few years, the Department took only 500 sets of the lithographs instead of 1,000 copies of the series as originally arranged. In the meantime Broinowski had a number of the sets bound with appropriate text. The wording on the title-page of copies of this book in the Mitchell Library, Sydney, and the National Library, Canberra, reads: "Birds and Mammals of Australia. Issued under the Authority of the Department of Public Instruction of New South Wales. Drawn, lithographed and described by Gracius J. Broinowski. Sydney. Printed by G. Murray, 91 Clarence Street, Wynyard Square."

Another copy of the *Birds and Mammals of Australia* in the Mitchell Library lacks the words "Issued under the Authority of the Department of Public Instruction" on its title-page, but, on the verso of the title-page it has

the following dedication not present in other copies mentioned: "To the Hon. William Joseph Trickett, M.P., Minister for Public Instruction of New South Wales, this work is respectfully dedicated as a mark of appreciation of his successful efforts in the cause of Education, by his faithful servant, G. J. Broinowski." No date appears on the title-page. However, the dedication to W. J. Trickett on one of the two copies in the Mitchell Library indicates that the year of issue was either 1884 or 1885 because Trickett then held office as Minister for Public Instruction.

During this period Broinowski was in correspondence with Henry Sotheran & Co., with the object of bringing out a "small popular edition of the late Mr. Gould's Birds and Mammals of Australia." This proposed work may have been, in effect, the *Birds and Mammals of Australia* of which he had already produced copies from his "Birds and Mammals" series of pictures mentioned earlier.

Among correspondence in the possession of J. S. P. Ramsay of Sydney are copies of letters dated November 7, 1884, from Henry Sotheran & Co., the London booksellers, to Broinowski and to E. P. Ramsay (father of J. S. P.), who was, at the time, Curator of the Australian Museum, Sydney. Both letters relate to the proposed book.

Henry Sotheran & Co.
136 Strand,
London, W.C.
7th November, 1884.

Gracius J. Broinowski, Esq.,
171 Macquarie Street,
Sydney, N.S.W.

Dear Sir,

We duly received your esteemed favour of August 21st, written with a view to ascertaining whether we should be willing to allow you to reproduce and publish in the Colonies a small popular edition of the late Mr. Gould's Birds and Mammals of Australia, the copyright of which works we own.

Prior to receipt of your letter we had it in contemplation to produce such a work and now we are in correspondence with another firm in reference to it, the precise form and price are not yet settled.

Under the circumstances we regret we cannot at present entertain your proposal—we gather from your letter that you had already made use of part of the work—this we beg you will not issue as it might prejudice to a certain extent our own contemplated work and lead to unpleasantness, which, as matters stand, can now be well avoided.

We beg to remain, dear Sir,

Yours faithfully, etc.

Henry Sotheran & Co.

H. Sotheran & Co.,
36 Piccadilly,
London, W.
7th November, 1884.

Dear Mr. Ramsay,

I feel greatly obliged to you for drawing my attention to Mr. Broinowski's action and intentions. I had received a proposal from him a week or two before your letter came to hand, to enter into some arrangement with him for the

re-production of Gould's *Birds of Australia.* I think the protests you so kindly made in my behalf, together with my communication to him this mail—a copy of which I enclose—will effectually stop him from proceeding further with the reproduction. But in the event of his persisting to publish, or to announce any such work, I have acted on your suggestion of sending you, enclosed, a power of attorney, to enable you to get an injunction forthwith. I here just state that I have contemplated an issue, in some form or other, and it is possible (if certain negotiations which are now proceeding are brought to a successful issue) that I may bring out the work, in conjunction with a well-known firm in a reduced form, so as to be popularised in the Australian Colonies.

By this mail you will receive Invoice of the "Gould's Works" ordered by you, which I hope you will receive safely and be bound to your liking.

"Audubon" as you know is exceedingly scarce—we cannot now find a copy but have one in view—a fine copy in private hands which we hope to get into our possession by exchange or purchase.

Thanking you again for your kindness and promptitude in the foregoing matter and trusting that coercive powers may not be necessary and so give you no further trouble.

Believe me to remain,

Yours very truly,

Henry Sotheran.

P.S. Power of Attorney will follow next mail—it is not ready this afternoon.

The "Birds and Mammals" series of pictures, which were also used (with the addition of appropriate text) in the *Birds and Mammals of Australia* are, generally speaking, based on the plates in Gould's *Birds of Australia* and his *Mammals of Australia,* but they are not precise copies from those sources. In some instances it seems that the designs have been copied direct on to the stone, with the result that the figures on the printed sheets face the opposite way to those in the relevant Gould plates. In other cases attitudes have been changed slightly, as have backgrounds. Nevertheless, the influence of Gould is quite apparent, a fact that doubtless resulted in the decision by Sotheran & Co. in the matter of copyright.

Presumably, on receipt of Sotheran's letter, Broinowski ceased publication of his *Birds and Mammals of Australia* which was thought to have been issued in a limited edition for private circulation (Iredale, 1956, p. 14). In producing this book Broinowski probably had in mind the marketing of the 500 sets of pictures left on his hands by the Department of Public Instruction.

The *Birds and Mammals of Australia* contains 16 full-page coloured lithographs of birds and 16 double-page lithographs of mammals [1] together with related text. The few copies known are bound in full dark maroon leather and titled in gold on the cover and the spine.

Assuming that the "small popular edition of the late Mr. Gould's Birds and Mammals of Australia" that Broinowski had in mind when he wrote Sotheran & Co. in August, 1884, is the same item as his *Birds and Mammals of Australia,* then the word "small" in the above context may have meant limited in scope. Broinowski's *Birds and Mammals of Australia* measures 14" x 10½", as against 21½" x 14½" for Gould's folios; also, it contains only 32 plates, whereas Gould's *Birds of Australia* comprises 681 plates (including those in the Supplement), and his *Mammals of Australia,* 182 plates.

---

[1] A copy of this work in the National Library, Canberra, lacks one plate, that of the Wombat.

It may be mentioned, in the matter of copyright, that soon after Gould's death in 1881 Henry Sotheran & Co. bought from his executors the remaining stock of his works which consisted of many hundreds of parcels, weighing upwards of thirty tons, containing original drawings, sketches, tracings, proof and experimental plates and other material accumulated by Gould during his long career as an ornithologist, author and publisher (*Piccadilly Notes*, No. 22, n.d.)

In the circumstances, as detailed in the letters quoted, Broinowski did not proceed with the issue of his "small popular edition" of Gould's Birds and Mammals. However, he had gathered, over a considerable number of years, material for a folio work on the birds of Australia. A note announcing the impending publication of this work appeared in the *Sydney Morning Herald* of March 28th, 1887: it reads:—

> "Mr Gracius Broinowski, an artist who has made the painting of birds his study for many years, is bringing out a book upon Australian birds, which will be most valuable to lovers of the feathered tribe. The work has been a long time in preparation, but, as the result Mr. Broinowski has made sketches of the whole of the existing birds of the country. The book will be issued in parts. After being lithographed the illustrations will be finished by hand painting, and every endeavour will be made to keep true to nature. We have seen specimens of the work, and can speak of it in the highest terms of praise. The birds appear true to life, being carefully and accurately drawn and very artistically arranged. Accompanying each will be a letterpress description of the habits, character, and nature of the birds. The descriptions we read were not of the dry, technical nature, but more in a narrative form, giving every possible information in connection with each group or species. The work will be concluded with a number, which will give a thoroughly scientific classification of the birds. It is expected that the whole will be completed in 60 or 70 numbers. There will be about 300 plates, including between 700 and 800 varieties, comprising all the known birds of Australia."

This newspaper report prompted Dr. E. P. Ramsay, who still held the Power of Attorney given him by Sotheran & Co. in 1884, to write immediately to Broinowski informing him "in a friendly manner" that no infringement of Gould's copyright would be tolerated. Ramsay's letter is as follows:—

Australian Museum,
28th March, 1887.

Dear Sir,

As I see by the paper (*Sydney Morning Herald*, March 28, 1887) that you are about to bring out a work on Australian Birds, I beg to say that in conjunction with Mr. Sotheran, who has purchased Gould's copyright, I am writing a book on the same subject. I therefore wish to inform you in a friendly manner that if any infringement either in description, nomenclature, classification or otherwise takes place I shall be obliged under my Power of Attorney from Sotheran & Co. to take proceedings against its issue.

I am,

Dear Sir,

Yours truly,

E. P. Ramsay.

Mr. Gracius Broinowski.

The illustrations in the *Birds of Australia* are based on drawings by Broinowski himself and are not copies of Gould's plates. Nevertheless, it would appear, from the following letter among the Ramsay papers, that Broinowski had been in touch with Sotheran & Co. over some aspect of Gould's copyright, and the use of his material.

Private.

54 Kent Street, N.,
Miller's Point,
Sydney.
17th July, 1888.

Dear Sir,

re Broinowski's "Birds"

In our one or two conversations respecting the above work I omitted to enquire particularly from you to what extent Gould's work is protected by copyright—taking it, of course, for granted that H. Sotheran would not have especially empowered you to act for him in support of his interests in Gould were they not copyrighted.

I hear casually today that Mr. B. has received a letter from Sotheran which, if I am rightly informed, virtually accords him permission to make all the use of Gould that he sought. This seems so opposed to your views that I cannot refrain from acquainting you with the rumour—leaving you to assess its worth.

I also hear that Mr. B., is, on the strength of Sotheran's permission, again canvassing for a publisher to proceed with his moribund publication!

Yours faithfully,

To Dr. Ramsay F. Ruthven

The *Birds of Australia* was commenced in 1887 but, through lack of funds, had ceased publication in 1888 after the issue of only six parts. Broinowski still had not disposed of the 500 sets of his "Birds and Mammals" pictures prepared a few years previously for the Department of Public Instruction. In an effort to realise on this "asset", apparently now free of any restriction of copyright, and so obtain funds for the continuance of his *Birds of Australia,* he asked Edmund Barton to write to Sir Henry Parkes on his behalf in April, 1888. A few months later, in August, Broinowski also wrote to Parkes seeking his aid in the same matter.

Edmund Barton, later to become the first Prime Minister of Australia and to be knighted, had earlier lodged with Broinowski in Sydney. Sir Henry Parkes was, at the time, Premier and Colonial Secretary of New South Wales. Among Parkes' papers is an unsigned and undated memorandum in which Broinowski's position is discussed. The letters, both from Barton and Broinowski to Parkes, and the memorandum, are given hereunder.

Barton to Parkes. Parkes Correspondence, Mitchell Library, Sydney, Vol. 2, A872, pp. 321-2.

Denman Chambers,
Phillip Street, Sydney
30th April, 1888.

Dear Sir Henry Parkes,

I am anxious to introduce to you a gentleman who has been involved in much fruitless labour and heavy pecuniary loss in the preparation of a scientific work at the instance of one of the Government Departments, which is now unable or unwilling to accept copies to the number actually ordered. The preparation of the balance over the number accepted has been the cause of the loss to which this gentleman, Mr. G. J. Broinowski, has been subjected. He is an artist by profession, and is also a Bachelor of Science of the University of Munich.

The work is I believe of a high order of merit, both as regards its scientific value and the taste, accuracy and elegance of its execution; and I believe that the refusal to accept the remainder of the copies ordered does not arise from any objection to the work itself.

Mr. Broinowski believes that if you could afford him a short interview he would be enabled to convince you completely that he has but carried out his part of a plain agreement and that he is entitled to be paid for the labour, research, and expenditure which he has been led to undertake.

As the final rejection of Mr. Broinowski's claim may involve him in utter ruin from that cause, and that cause alone, I venture to hope that you will accede to his, and my, request, and name a time on any day this week after Tuesday at which you may be able to give a little of your precious time to the hearing of this gentleman's grievance.

I am, dear Sir Henry Parkes,

Very faithfully yours,

Edmund Barton.

The Honble
Sir Henry Parkes, G.C.M.G., M.P.
Colonial Secretary.

Broinowski to Parkes. Parkes Correspondence, Mitchell Library, Sydney. Vol. 3, A873, p. 504.

Sydney
28-8-1888.

To the Right. Hon. Sir Henry Parkes, G.C.M.G. etc. etc. etc.

Sir,

Knowing how precious your time is I venture to concisely present the facts relative to my publication "The Birds of Australia" for your consideration.

1. I am the sole possessor of all the materials—acquired by 29 years of labour—necessary for the publication of an exhaustive work upon the "Birds of Australia."
2. I have commenced the publication and six numbers have been issued to the public. But owing to want of funds the work has come to a stand-still.
3. The continuance and success of the publication would be assured if you would sanction the further issue to the public schools of the balance of the charts of Birds and Mammals of Australia left upon my hands by the Department of Public Instruction contrary to an understanding upon which the original order was executed.
4. I crave your powerful aid towards the publication, trusting that you will consider the fact that Australia is the only civilised country which has no popular natural history published, notwithstanding that her fauna possesses the highest scientific value and ranks only second in point of numbers to that of any other country in the world. Moreover such a work will soon be difficult if not impossible to accomplish as the birds of Australia are being wantonly destroyed, and stuffed specimens at the Museums are perishable and unfit as subjects for illustrations.

G. J. Broinowski.

Memorandum, unsigned. Parkes Correspondence, Mitchell Library, Sydney. Vol. 5, A875, pp. 88-90.

Memorandum.

Mr. Broinowski is a foreigner—an enthusiastic Artist and Naturalist.
Upon some verbal arrangement he was led to produce 1,000 copies of his "Birds and Mammals" for school use, by the late Government.
The price per copy or set was fixed upon the understanding that 1,000 at least would be required and taken from him.

Up to the time of the late Government losing office they had only taken one half of the order.

By the remainder being, so far, thrown upon his hands he has been placed in a position of great pecuniary embarrassment. Relying upon the bona fides of his claim he has partly prepared a long projected work upon the "Birds of Australia." This has only added to his troubles and for want of funds he has been compelled to stop publication, as he can neither properly canvas the work nor continue the printing and preparation of it.

If the Government take the 500 copies for their schools which he prepared for them he can again start and continue to give employment to writers, artists, printers &c, &c, who are necessary to its production and who have been thrown out of employment by the suspension of publication.

Volume 3 was the first of six to be published because its contents were in the most forward stage of production; of the six parts of that volume appearing before publication was held over in 1888, parts 1, 2, 4 and 5 were "Published by the Proprietor" (i.e. Broinowski), while parts 3 and 6 bear the imprint of Charles Stuart and Co., who, obviously, must have been involved, if only in part, as publishers of the project.

Early in 1889 Broinowski arranged with Charles Stuart & Co. to again handle his *Birds of Australia:* this is evident from the following letter written by M. A. Manning to Dr. E. P. Ramsay, of the Australian Museum. Ramsay Correspondence, in possession of J. S. P. Ramsay, Sydney.

Stanbury, Marrickville,

February 7, 1889.

Dear Dr. Ramsay,

I have twice tried to find you at the Museum but each time unsuccessfully. It was to ask the favour of your advice about a matter upon which no one can advise so well.

Mr. Broinowski tells me that he has handled over his "Birds work" in part to Stuart & Co., the publishers, who are to begin work again at once, and that you have promised all assistance in your power.

He has offered me the Letterpress work again at the old terms—£8/0/0 a month—terms to which I objected before as being inadequate, but he says Stuart & Co. refuse to give more, as they can get others to do it for less. That the man White, who undertook before me, did it for half the sum and was fully competent, being a member of the Linnean Society. I suppose I ought to believe all this but somehow I don't, in vulgar parlance "it won't wash."

At the same time I know there are many educated and needy writers who might be glad of such employment.

What do you advise?

I am sorry to have to trouble you to answer this but I am rather perplexed.

With many apologies,

I am,

Sincerely yours,

M. A. Manning.

Prior to 1889 six parts only of volume 3 of the *Birds of Australia* had been issued. Four of these parts (1, 2, 4 & 5) were issued by Broinowski and each contained four plates, the price being five shillings per part. The other two parts (3 & 6), of eight plates each, were published by Stuart & Co., and were sold for ten shillings per part.

In 1889, when Charles Stuart & Co. resumed as publishers, the *Birds of Australia* appeared regularly in parts, commencing at part 7 of volume 3, to be completed, on the issue of the 40th part, in 1891. Parts were sold at 10/- and contained either 6 plates (3 parts), 7 plates (1 part), 8 plates (30 parts) or 10 plates (2 parts).

In most sets the title-page of volume 3 bears the imprint of Charles Stuart & Co. and is undated. However, in an unbound set in parts in the Mitchell Library and a bound set in the National Library, volume 3 is dated 1887 and the words "Published by the Proprietor" appear on the title-page.

The "1887" title-page was issued by Broinowski with the first part of volume 3, but when Charles Stuart & Co. completed the volume they issued the undated title-page, bearing their imprint, which is the one bound with most sets. Probably Stuart & Co. issued parts 7 and 8 of volume 3 shortly after February 1889, for it was then that they were ". . . to begin work again at once" (letter, Manning to Ramsay, February, 1889, q.v.), so that the year 1889 may provisionally be quoted as the correct year for the completed volume.

Volume 2 is undated. However, Mr. L. K. Paszkowski of Melbourne, informs me that, in the set of the *Birds of Australia* in the State Library of Victoria, volume 2 bears the rubber stamp entry "10 Oct. 89", a fact indicating that 1889 is the year of publication.

The forty parts comprising the six volumes were published over a period of four years—1887-1891. The title pages of the various volumes state that the complete work contains 300 full page illustrations; the actual number is 303. A note in manuscript appended to a printed prospectus of 1897 (q.v.) for another book contemplated by Broinowski states that the *Birds of Australia* was "Published at £19/0/0, and £24/0/0 bound in cloth. Ed. . . ." Elsewhere, in another prospectus of 1910 (q.v.) Broinowski gave the price as £19/10/0 unbound.

Some sets are bound in six volumes either in dark blue or dark brown cloth boards titled on the spine and cover, which is stamped in gold in an elaborate design embodying a number of bird species. Other sets are more plainly bound in three volumes. The plates are printed in several colours from the stone and are not, as far as I can ascertain, "finished by hand-painting" (*Sydney Morning Herald*, 28/3/1887) or "washed over with water-colours" (Mathews, 1942, p. 198).

In the complete set, in parts as issued, of the *Birds of Australia* in the Mitchell Library the part and volume number, but not the contents, are indicated on the printed covers. Parts 1 of volumes 1, 3 and 6 contain title-pages to their respective volumes. No title-pages appear in any of the parts of volumes 2 and 4. The title-page to volume 5 is included in part 6 of volume 4, together with two plates and relevant text belonging to volume 5. The plate numbers commence from 1 in each of the six volumes. The part numbers on the wrappers agree with the run of plate numbers in all volumes except volume 3, the one commenced by Broinowski and later controlled by Charles Stuart & Co.

The unbound set in the Mitchell Library was transferred from the Chief Secretary's Department in 1956. It was part of a collection associated with the name Sir Henry Parkes. A full collation of this set follows:—

Volume	Date	Part No.	Plate No.	Remarks
1	1890	1	1-6	Contains title-page dated 1890.
		2	7-14	
		3	15-22	
		4	23-30	
		5	31-38	
		6	39-46	
		7	47-52	
2	N.D. (1889)	1	1-8	Contains undated title-page
		2	9-16	
		3	17-24	
		4	25-32	
		5	33-40	
		6	41-48	
		7	49-58	
3	?1889[2]	1	1-4	Contains title-page dated 1887
		2	5-8	
		3	9-16	Cover marked "No. 2"
		4	17-20	Cover marked "No. 5"
		5	21-24	Cover marked "No. 6"
		6	25-32	Cover marked "No. 4"
		7	33-40	Cover marked "No. 5"
		8	41-48	Cover marked "No. 6"
4	1890	1	1-10	
		2	11-18	
		3	19-26	
		4	27-34	
		5	35-42	
		6	43-48	Contains title-page of volume 5, dated 1891, and plates 1 and 2, with text, of volume 5.
5	1891	1	3-10	
		2	11-18	
		3	19-26	
		4	27-34	
		5	35-42	
		6	43-50	
6	1891	1	1-8	Contains title-page dated 1891
		2	9-16	
		3	17-24	
		4	25-32	
		5	33-40	
		6	41-47	Contains Index pp. 1-30 and errata sheet.

[2] Parts 1, 2, 4 and 5 of this volume were published by Broinowski; parts 3, 6, 7 and 8 by Stuart & Co., who issued a new and undated title-page.

Between 1887 and February, 1889, when publication of the *Birds of Australia* was in suspense after the appearance of six parts of volume 3 (the first to be issued), Broinowski published, in book form, the first 11 plates and relevant text under the title *The Pigeons of Australia;* and the next 13 plates and text under the title *The Cockatoos and Nestors of Australia*[3]. Both these books bear the year 1888 on their title-pages.

It is not certain whether the "Pigeons" and the "Cockatoes and Nestors" were issued privately or placed on the open market. Only a few copies of either book are known. Broinowski remarked in his letter of August, 1888, (q.v.) that his *Birds of Australia* was then in suspense through lack of finance. Perhaps he decided to issue the first 24 plates of volume 3 as two separate books, thus hoping to obtain enough money to continue his main work, the *Birds of Australia.*

BROINOWSKI'S PROSPECTUSES.

Three known prospectuses, issued under the name of Broinowski subsequent to the completion of his *Birds of Australia* in 1891, are for books that did not reach fruition. The earliest of the three is one dated 1897 that came into my possession in 1965 through the kindness of Mr. O. Warland, who obtained it from the Simmons-Bloxham Printing Company Ltd., when he was employed by that firm in 1910. Broinowski may not have gone ahead with this proposed book because of the financial depression existing at the time; or, perhaps, the witholding of support for a work lacking in originality may have been the deciding factor in the abandonment of the *Avi-fauna of Australia* (1897) as the book was to be called. Had such a work been published it would have been, in the main, an illustrated Gould's *Handbook,* and its chief use the handy quarto size of the colour-plates which are excellent examples of chromo-lithography.

The 1897 *Avi-fauna of Australia* prospectus (another of the same title was issued by Broinowski in 1910) is bound in dark-green cloth boards, with a blind tooled border on the front cover and the words "The Avi-fauna of Australia, Vol. 1" in gold on the spine. It contains a title-page, an "Advertisement" or introduction, several pages of text and four plates in colour, but lacks an imprint. The cover measures 11½" x 9", the spine is 2" wide, and the sheets are 11" x 8½".

In his "Advertisement" Broinowski states that "The contents of the following pages are imitations, or more correctly, *fac-simile* reproductions of Gould's famous work, the "Birds of Australia," with additions of extracts from the works of many other eminent Ornithologists, and original representations of the birds discovered in Australia since 1848." He also reveals that "As a further proof of the prevailing need of a comprehensive work on the ornithology of Australia I may mention that in 1890, after varied experiences in minor works upon the same subject, I issued a completed edition of 'The Birds of Australia'[4]. The work was complete, but it was an impared (sic) completeness, owing, perhaps, to an error of judgment. The fear of failure,

---

[3] Item 7457a in Ferguson (*Bibliography of Australia,* Vol. 5, 1963, p. 426) states, under this title, that the work contains 24 full-page plates. In this case two separate books are involved—the "Pigeons" (11 plates) and the "Cockatoos and Nestors" (13 plates), both of which are in the National Library, Canberra. The error in ascribing the 24 plates to the one title was caused by inexact descriptions having been given to Sir John Ferguson.

[4] Volumes 5 and 6 of the *Birds of Australia;* both have the year 1891 on their title-pages.

on the score of expense, induced me to group the illustrations so as to reduce the number of plates to three hundred. It was a mistake in more ways than one. Nevertheless, the Australian public monopolised the whole edition of a thousand copies, without so much as a single copy finding its way beyond the Australian colonies."

The four plates in this prospectus are printed in either five or six colours by chromo-lithography; all, except the plate of Rawnsley's Bowerbird, have associated texts taken direct from Gould. According to Broinowski the illustrations are "imitations, or more correctly, *fac-simile* reproductions" of Gould's plates. But such is not precisely the case. Rather, they are either close copies of Gould's figures (Western Bower-bird, Rawnsley's Bower-bird) or variants in posture, or with the addition of other figures, as is the case with the plates of the Pale-headed Rosella and the "Yellow-rumped Diamond-bird."

The Pardalote figured is the Yellow-tailed species (*Paradalotus xanthopygus*) yet the text relates to the "Yellow-rumped Diamond-bird" or Pardalote (*P. uropygialis*) of Gould, which bird is quite distinct from the Yellow-tailed Pardalote and is now considered to be a form of the Black-headed Pardalote (*P. melanocephalus*).

Some 70 years after the preparation of the 1897 prospectus one of the plates therein, that of Rawnsley's Bower-bird, was reproduced twice. The first time in *People*, a weekly magazine, on November 4, 1964, p. 17, to illustrate an article by A. H. Chisholm titled "The Strange Case of the Blue Regent" (shades of Sherlock Holmes); on the second occasion, in the *Queensland Naturalist* (vol. 17, June 1965, p. 88) to illustrate observations, also by A. H. Chisholm, on "Some Queensland Mystery Birds."

Copies of the other two prospectuses mentioned are in the Mitchell Library. Both bear the date 1910 but have different titles and imprints. At the time Broinowski was 73 years old and had but three years to live. Mathews, in his biographical notes on Broinowski, says of him that towards the end of his life "failing health compelled his retirement from all forms of activity, and, although he dreamed of issuing a new book on birds at popular prices (sic), he no longer had the energy to do more than plan the work" (1942, p. 199).

One of the 1910 prospectuses has the same main title, i.e. *The Avi-fauna of Australia*, as the one of 1897 previously discussed, but differs entirely in format. Five pages of text, printed on one side of the sheets only, and a colour-plate, comprise the prospectus which bears the imprint of John Sands Ltd., Sydney, as publishers. The colour-plate, from blocks, shows twelve species of birds reproduced from paintings by Broinowski. The figures are in separate panels, three across and four down, each panel measuring approximately 1" x 2", the overall size of the sheet being 10" x 6½". The text is made up of an introduction of two pages, notes on the Kookaburra or Laughing Jackass (called by Broinowski the Gogobera) and two pages of observations on the Superb Lyrebird; the whole on art paper.

On the title-page it is stated, among other things, that Broinowski is the author of "Pigeons and Parrots of Australia"; no such book is known, the title quoted is apparently an error for the *Pigeons of Australia*. His "Birds and Mammals" series of pictures is given as "Birds and Mammal (sic) of Australia for Public Schools." The "Cockatoos and Nestors" is also noted.

In discussing his proposed *Avi-fauna of Australia* of 1910 Broinowski states:- ". . . to portray from life the many hundreds of birds scattered over the length and breadth of Australia, demands not only the labour of years, but entails hardships and difficulties of which the lay mind can form no conception.

"It so happens, however, that this has already been done effectually— how, or at what cost, need not be referred to. Suffice it to say that the results, fully effective today as they have been before, are about to be utilised

in the production of an entirely new and popular edition of 'The Avi-fauna of Australia.' But, contrary to what has been done before, the book will be published at such a modest price as to bring it within the scope of the sorest need, in the confident hope that it may prove the saving grace of our invaluable heritage.

"The accompanying plate (one of 54) is a specimen of the proposed work. Should this meet with public approval and sympathetic interest, the work will be faithfully carried out in accordance with the sample, and on completion a select copy of the first edition, handsomely bound in cloth, will be forwarded to every subscriber who has volunteered his help by sending his subscription in advance. The Author."

It would seem, from the above remarks, that Broinowski had prepared at an earlier date the 54 plates he intended using in his *Avi-fauna of Australia* of 1910; if such plates were then in existence their present whereabouts is not known.

The other, and third, prospectus, is in royal 8vo and has a cover in colour with the title *Gould's Birds of Australia,* followed by the words "Published in monthly parts, price 2/6." The design on the cover shows a Prince Albert Rifle-bird perched on a branch, with a background depicting a tree-lined river. The attitude of the bird, presumably painted by Broinowski, is similar to that of the same species appearing on plate 7, of volume 4, of his *Birds of Australia.*

The title-page is dated 1910 and has the name of the Simmons-Bloxham Printing Company Ltd., as printers below a space left blank for a publisher's name. It is stated on the title-page that the illustrations will be printed in colour from "Tri-chromatic Blocks by Bacon & Co.". The introduction occupies one page and the text covers four pages for each of the two colour-plates. Each plate depicts twelve species of birds of prey, three across and four down on a sheet. The figures are numbered 1 to 12 respectively and are close copies taken from Gould's *Birds of Australia.*

In his introduction to this prospectus Broinowski states that "The work will comprise upwards of 1,000 figures in colour, representing 694 distinct species, all fully, if briefly, described as far as possible up to date. It will be published in 30 parts of 24 subjects each (i.e. two plates) payable on delivery. The last part will contain an Introduction, Indexes, Classification Tables, and every other requisite to make the whole into a complete volume."

At a later date someone has written the following words on the cover of the prospectus: "This came to nothing. The Mitchell ought to bind this 'specimen'," remarks presumably meant to be facetious.

SUMMARY

In retrospect it is seen that Broinowski produced in the early 1880's a series of large coloured lithographs of Australian birds and mammals for use in schools. Sets of these illustrations, together with appropriate text, were bound under the title *Birds and Mammals of Australia* and issued in the mid-1880's.

Broinowski's main work, the *Birds of Australia,* in six volumes (some sets are bound in three volumes) appeared between 1887 and 1891. Volume 3, commenced in 1887 and completed in 1889 was the first to appear. The first 11 plates and text of this volume were issued in 1888 under the title *The Pigeons of Australia.* The following 13 plates and text appeared in book form, also in 1888, under the title *The Cockatoos and Nestors of Australia.* Only a few copies of these two works are known.

In addition, three prospectuses have been recorded. One bears the date 1897, the other two were prepared in 1910, three years before Broinowski's death. None of these projects reached finality.

Acknowledgements

Sincere thanks for co-operation and advice are extended to Mr. J. S. P. Ramsay and Gilbert P. Whitley, of Sydney; Mr. L. Paszkowski of Melbourne; Mrs. Marjorie Hancock, Deputy Mitchell Librarian, Sydney; Miss Mary Davies, Librarian, Australian Museum, Sydney; and Mr. H. L. White, National Librarian, Canberra.

Permission to reproduce material in the Mitchell Library has been kindly granted by the Trustees of that Institution.

References.

Iredale, Tom, 1956.—"Broinowski's Birds and Mammals of Australia," *Proc. Roy. Zool. Soc., N.S.W. (1954-5)*, pp. 14-16.

Mathews, Gregory, 1942.—"G. J. Broinowski." *The Emu*, vol. 41, pp. 195-9, pl. 29.

Moore, William, 1934.—*The History of Australian Art*, vol. 1, pp. 56-7.

Paszkowski, L., 1962.—*Polacy w Australii i Oceanii 1790-1940*, pp. 41, 91, 93-4, 181-3, 290, 332, pls. 48-9.

THE STATUS OF THE CRAB GENUS **EUPLAX** H. MILNE EDWARDS, 1852; AND A NEW GENUS **AUSTRALOPLAX** OF THE SUBFAMILY MACROPHTHALMINAE DANA, 1851 (BRACHYURA: OCYPODIDAE)

By R. S. K. Barnes

N.A.T.O. Postgraduate Research Student, Zoology Department, University of Queensland.

(Plate XXIV)

SUMMARY

The history and status of the genus *Euplax* H. Milne Edwards, 1852 are discussed. *E. leptophthalmus* H. Milne Edwards, 1852, and *E. boscii* (Audouin, 1826) are referred to the genus *Macrophthalmus* Latreille, 1829. *E. tridentata* (A. Milne Edwards, 1873) is referred to the new genus *Australoplax*. Comparison is made between *Australoplax* and *Macrophthalmus*, and a key to the Australian genera of the subfamily Macrophthalminae Dana, 1851 is given.

INTRODUCTION AND STATUS OF THE GENUS *EUPLAX* H. MILNE EDWARDS, 1852

The genus *Euplax* was erected by H. Milne Edwards (1852: 160) to receive the new species *Euplax leptophthalmus* H. Milne Edwards, 1852, collected in Chile, South America. That author, in the same paper, also transferred *Macrophthalmus boscii* of Audouin, 1826 to the new genus. A third species was added to *Euplax* by McCulloch (1913) following suggestions made to him by Rathbun. McCulloch sent material of *Metaplax hirsutimana* Grant and McCulloch, 1906 to Rathbun, and she (quoted by McCulloch, 1913) showed that *M. hirsutimana* was synonymous with *Cleistostoma tridentatum* A. Milne Edwards, 1873 (b), and on comparing McCulloch's specimens with material of *Euplax boscii* (Audouin) suggested transferring *C. tridentatum* to *Euplax*. De Man (1896) had earlier suggested the transference of that species from *Cleistostoma* de Haan, 1835 to *Chaenostoma* Stimpson, 1858 (= *Euplax* H. Milne Edwards). Three species have thus been placed in the genus *Euplax*.

The type species of *Euplax*, *E. leptophthalmus*, is known only from the very brief original description of H. Milne Edwards ("Carapace presque aussi longue que large. Podophthalmites médiocres, ne dépassant guère en longueur la largeur du front. Hectognathes comme chez les Macrophthalmes. Chélopodes courts dans les deux sexes" (referring to the generic characters) and "Podophthalmites très grêles et beaucoup moins longs que les orbites. Front médiocre. Carapace armée de trois dents latérales, large et relevées—Chili" (referring to the specific characters)) and from a male and female specimen deposited in the Muséum National d'Histoire Naturelle, Paris by H. Milne Edwards. No further specimens have been discovered.

In Milne Edwards' generic and specific descriptions no characters are given by which *Euplax* can be distinguished from broad or medium fronted species of *Macrophthalmus*. This, however, is not surprising since the only broad fronted species of *Macrophthalmus* known prior to 1852 was *M. boscii*, which was transferred by Milne Edwards to *Euplax*. Since 1852, however, many broad fronted species of *Macrophthalmus* have been described, e.g. *M. quadratus* A. Milne Edwards, 1873 (a); *M. punctulatus* Miers, 1884; *M. erato* de Man, 1888 and *M. franchettii* Maccagno, 1936. These species have sub-quadrate carapaces, ocular peduncles approximately equal in length to the width of

the front, and short, rather than elongate, chelipeds. Thus no generic characters are given by Milne Edwards differentiating *E. leptophthalmus* from these *Macrophthalmus* species.

Madame Guinot of the Paris Museum has kindly provided a series of photographs of the type male specimen of *E. leptophthalmus* (see pl. XXIV, figs. 3 and 4). This species appears to be closely related to *Macrophthalmus latreillei* (Desmarest, 1817) and *M. gastrodes* Kemp, 1915 in characters of the external maxilliped, epistome, abdomen, front, shape of carapace and surface carapace granulation. It possesses no characters that do not occur in *Macrophthalmus* species, and occupies a position well within the currently recognised range of that genus (see Tesch, 1915; Sakai, 1939; Crosnier, 1965 etc., and the comparison between the genera *Australoplax* and *Macrophthalmus* discussed later).

Many recent authors, including Kemp, 1919, Balss, 1935, Bernard, 1950 and Crosnier, 1965 have transferred *Euplax boscii* back to its original genus, *Macrophthalmus* Latreille, 1829, and after the examination of South African and Australasian material of that species by the author, no characters have been seen which warrant the removal of *M. boscii* from the genus *Macrophthalmus*.

The third species, *Euplax tridentata*, however, exhibits many characters which lie outside the range of variation seen in *Macrophthalmus* (discussed later), and which warrant the placing of that species in a distinct genus, *Australoplax* gen. nov.

SYSTEMATICS

AUSTRALOPLAX, gen. nov.

Type species:— *Cleistostoma tridentatum* A. Milne Edwards, 1873 (see pl. XXIV, figs. 1 and 2).

Description and Diagnosis

Front: Broad, depressed; unconstricted between ocular peduncles; and with obtusely pointed anterior margin.
Orbits: Short, but occupying whole of anterior border of carapace between front and external orbital angles; upper orbital border sinuous, backwardly sloping and without granules; lower orbital border projecting, smooth and with small concavity in central region in males, regularly tuberculated in females.

Interantennulary septum: Narrow, but broader than in *Macrophthalmus*.

Epistome: Long and narrow; central region with sharply pointed lobe.

Anterolateral teeth: External orbital angle forms first lateral tooth; first and second lateral teeth large, broad and rectangular; third lateral tooth very small.

Carapace: Subquadrate, but with greatest breadth slightly exceeding length; depressed; with indistinct furrows, excepting circumgastric and circumcardiac; with variable surface "hair"; lateral margins subparallel.

Ocular peduncles: Short and stout.

Chelipeds: Equal or subequal in both sexes. In males well developed; merus triangular in transverse section; palm globose; index deflected upwards at tip; no differentiated teeth on either cutting margin; latter obscured both internally and externally by mat of hair. In females weak.

Ambulatory legs: Second and third pairs largest and subequal, fourth pair smallest. Meri long and with small subterminal spine on upper margins.

Male abdomen: Composed of seven distinct segments, first two small. Fourth and fifth segments with lateral margins strongly divergent towards fifth and sixth segments respectively; sixth segment very large, with lateral margins convergent towards small seventh segment.

External maxilliped: Merus large, subquadrate, subequal to, but slightly smaller than, ischium. Ischium with transverse/oblique rows of hairs across base.

First male pleopod: Slightly curved shaft, but not recurved upon itself.

Discussion

The following table shows characters of *A. tridentata* which differ from those in *Macrophthalmus*.

A. tridentata	*Macrophthalmus* species
1. Chelae of male globose; with an upwardly deflected index; without any differentiated teeth on the cutting margins of index and dactylus; and with both cutting margins obscured externally by thick 'hair.'	Chelae of male never globose; with straight or downwardly deflected index; with tooth on cutting margin of dactylus, and often on cutting margin of index; cutting margins never obscured externally by 'hair.'
2. Male abdomen broad; with fourth and fifth segmental lateral margins strongly divergent towards fifth and sixth segments; sixth segment very large with lateral margins strongly convergent towards seventh segment.	Male abdomen narrow; with third to sixth (inclusive) segments subequal; lateral margins of fourth to sixth segments (inclusive) straight or regularly convergent towards morphological posterior.
3. Ischium of external maxilliped with transverse/oblique row of 'hairs' across base.	Ischium of external maxilliped without any rows of 'hairs' across base.
4. Anterior margin of front obtusely pointed.	Anterior margin of front straight or bilobed, never pointed.
5. Interantennulary septum broader than in *Macrophthalmus*.	Interantennulary septum narrow.
6. Central region of epistome with sharply pointed triangular lobe.	Central region of epistome concave, convex or straight.
7. Lower orbital border of males smooth, without granules or tubercles, and with concavity in central region.	Lower orbital border of males with large pointed tubercles, never smooth, and without central concavity.
8. Upper orbital border without granules.	Upper orbital border usually with rounded granules.

Australoplax, however, shows closer affinities with *Macrophthalmus* than with any other genus in the subfamily, and in particular with the broad-fronted species of *Macrophthalmus*. These species, and *Australoplax*, both show a subquadrate, depressed, carapace with three anterolateral teeth, the first two large, the third small; broad front; short ocular peduncles; pereiopod meri with small subterminal spines on the upper margins; second and third pairs of pereiopods largest, fourth pair smallest; abdomen consisting of seven distinct segments, the first two small; external maxilliped with subequal merus and ischium; and a slightly curved (or straight) shaft of the first male pleopod.

Australoplax gen. nov. contains only one species, *A. tridentata* (A. Milne Edwards, 1873).

Australoplax tridentata (A. Milne Edwards, 1873).

Synonymy:

Cleistostoma tridentatum A. Milne Edwards, 1873b: 82.

Chaenostoma tridentatum (A. Milne Edwards), de Man, 1896: 93-95, pl. 3, fig. 5 (not fig. 4 as in text).

Metaplax hirsutimana Grant and McCulloch, 1906; 21, pl. 1, fig. 3.

Euplax tridentata (A. Milne Edwards), McCulloch, 1913: 321. Tesch, 1918: 59. Rathbun, 1926: 177. Stephenson *et al.*, 1931: 42. Snelling, 1959: 70.

Material examined: 107 males (2.7-15.3mm.); 66 females (3.9-14.0 mm.); ovig. females (8.3-13.2 mm.) (dimensions given are those of greatest carapace breadth).

Localities:
(a) *Queensland*: Cooktown, Cairns, Townsville, Yeppoon, Rockhampton, Gladstone, Port Curtis, Bundaberg, Noosa, Moreton Bay (Bribie Island, Sandgate, Cribb Island, Brisbane River, Dunwich, Lota), Gold Coast.
(b) *New South Wales*: Brunswick Heads, Ballina, Trial Bay, Sydney.

Diagnosis and Abbreviated Description

It is not here intended to give a full specific description, since such has already been given by de Man (1896), but it would not be out of place to give a list of characters of this species regarded by the author as being of a specific character.

Front: With smooth surface and wide median furrow.

Anterolateral teeth: External orbital angle large, pointed, directed outwards and forwards; with straight anterior margin; slightly convex outer margin, studded with few very small granules; separated from second lateral tooth by small but distinct V-shaped incision. Second lateral tooth broad, directed outwards, projecting beyond former tooth; with straight outer margin, diverging posteriorly. Third lateral tooth pointed.

Carapace: Surface smooth, without granules, but with sparse, scattered, short 'hairs' on branchial regions. Epigastric, gastric, cardiac and intestinal regions raised. Greatest breadth occurring between bases of second pereiopods.

Male cheliped:

(a) Merus

All surfaces without granules, scattered 'hair' on inner surface only. Upper and lower margins with longitudinal series of small granules; inner margin with longitudinal series of large tubercles, distal angle convex and with six or seven large tubercles along crest.

(b) Carpus

Smooth excepting a few granules on inner surface.

(c) Chela

Outer surface of palm smooth; inner surface smooth with mat of 'hair' near base of dactylus and index; upper and lower margins with longitudinal carinae, that of lower margin continuing along index.

Dactylus curved; inner and outer surfaces without granules; upper margin with longitudinal series of granules.

Outer and inner surfaces of index without granules.

Ambulatory legs: Upper margins of meri, carpi and propodi heavily 'haired', with mat or short brownish 'hairs' and sparse longer black 'hairs'.

Male abdomen: Intersegmental margins sinuous; lateral margins with fringe of sparse, long black 'hair.'

External maxilliped: Merus subquadrate; internal margin convex; external margin more or less straight. Internal and external margins of ischium straight.

Habitat: Littoral or supralittoral; in burrows in mud. Frequently estuarine.

Distribution: Eastern Australia (Grant and McCulloch, 1906; Rathbun, 1926; Snelling, 1959), ? Samoa (A. Milne Edwards, 1873).

Discussion

A. Milne Edwards in describing the species gave Upolu, Samoa as the type locality, but de Man (1896) in examining and redescribing the type material states (p. 93) "Das aus Hamburg empfangene Exemplar trägt auken auf der Etikette die Nummer 2429 und soll von Australien stammen, dagegen liegt in dem Gläschen die Nummer 3666a; es bleibt also fraglich, ob es dort oder auf Upolu gesammelt wurde." Thus the type locality of this species is either Samoa or Australia, which of the two, however, being open to doubt.

Key to the Australian genera of the subfamily Macrophthalminae Dana, 1851

1a. Pereiopods with transverse/oblique row of large tubercles across lower surfaces of meri .... *Leipocten* Kemp, 1915
(One Australian species — *L. sordidulum* Kemp, see Snelling, 1959).
b. Pereiopods without any transverse or oblique rows of tubercles across lower surfaces of meri .... 2.
2a. Merus of external maxilliped larger than ischium; ischium with large triangular antero-internal protuberance .... 3.
b. Merus of external maxilliped smaller than, or subequal to, ischium; ischium without large triangular antero-internal protuberance .... 4.
3a. Carapace domed; front without well developed 'horns' at anterolateral angles .... *Cleistostoma* de Haan, 1835
(One Australian species — *C. wardi* Rathbun, see Rathbun, 1926).
b. Carapace flattened; front with well developed anterolateral 'horns' *Paracleistostoma* de Man, 1895.
(One Australian species — *P. mcneilli* (Ward) comb. nov., see Ward, 1933).
4a. Cutting margins of dactylus and index of male chelae obscured externally by dense hair; dactylus without differentiated tooth on cutting margin *Australoplax*, gen nov
b. Cutting margins of dactylus and index of male chelae not obscured externally by hair; dactylus with differentiated tooth on cutting margin *Macrophthalmus* Latreille, 1829.
(Twelve Australian species at present under revision by the author).

Camptandrium Stimpson, 1858 and *Tylodiplax* de Man, 1895, the only other genera in the Macrophthalminae, have been excluded from the above key as they are not known from Australia and no species attributed to them have been seen by the author.

Acknowledgements

I am deeply indebted to the authorities of the Australian Museum, Sydney and of the Queensland Museum, Brisbane, for the loan of material; to Mr. N. E. Milward, M.Sc. of the Zoology Department, University of Queensland for the collection of material from Rockhampton; to Madame D. Guinot of the Muséum National d'Histoire Naturelle, Paris for her very generous assistance in providing excellent photographs of the type specimen of *M. leptophthalmus* and for her permission to publish some of them here; and to Dr. J. C. Yaldwyn and Professor W. Stephenson for help and criticism.

References

Audouin, V., 1826.—Explication sommaire des Planches de Crustacés de l'Egypte et de la Syrie, publiées par Jules-César Savigny, membre de l'Institut; offrant un exposé de charactères naturels des genres avec le distinction des espèces. Description de l'Egypte ou recueil des observations et des recherches qui ont été faites en Egypte pendant l'expedition de l'armée française *Histoire naturelle* 1 (4), 77-98. Paris.

Balss, H., 1935.—Brachyura of the Hamburg Museum Expedition to South Western Australia. 1905. *J. Roy. Soc. W. Aust. 21,* 113-151.

Barnard, K. H., 1950.—Descriptive catalogue of South African Decapod Crustacea. *Ann. S. Afr. Mus. 38,* 1-864.

Crosnier, A., 1965.—Crustacés Décapodes. Grapsidae et Ocypodidae. *Faune de Madagascar 18,* 1-143, 11 pl.

Dana, J. D., 1851.—Conspectus Crustaceorum quae in Orbis Terrarum circumnavigatione, Carolo Wilkes e Classe Reipublicae Faederatae Duce, lexit et descripsit J. D. Dana. *Proc. Acad. Nat. Sci. Philad.* 5, 247-254, 267-272.

Desmarest, A. G., 1817.—Crustacés fossiles. *Nouv. Dict. Hist. Nat.,* Paris, ed. 2, 8, 495-519 (*Goneplax latreillii,* page 502).

Grant, F. E. & McCulloch, A., 1906.—On a collection of crustacea from the Port Curtis district, Queensland. *Proc. Linn. Soc. N.S.W. 31,* 2-53, 4 pl.

Haan, W. de, 1835.—Crustacea. *In* P. F. de Siebold, Fauna Japonica sive Descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava Imperium tenent, suscepto, annis 1823-1830 collegit, notis observationibus et adumbrationibus illustravit. 1-244, pl. 1-55. J. Műller & Sons: Amsterdam.

Kemp, S., 1915.—Fauna of the Chilka Lake: Crustacea Decapoda. *Mem. Indian Mus. 5,* 199-325.

————, 1919.—Notes on Crustacea Decapoda in the Indian Museum. 13. The Indian species of *Macrophthalmus. Rec. Indian Mus. 16,* 383-394, pl. 24.

Latreille, P. A., 1829.—Les Crustacés, les Arachnides et les Insectes, distribués en familles naturelles. *In* G. Cuvier, Le Règne Animal, distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. 2me ed. *4,* 1-584.

Maccagno, T., 1936.—Crostacei di Assab. Decapodi, Stomatopodi, Anfipodi Spedizione del Barone Raimondo Franchetti i Doncalia. 1928-29. *Ann. Mus. Stor. Nat. Genova, 59,* 171-186.

McCulloch, A. R., 1913.—Studies in Australian Crustacea No. 3. *Rec. Aust. Mus. 9* (3), 321-353, pl. 10 and 11.

de Man, J. G., 1888.—Report on the Podophthalmus Crustacea of the Mergui Archipelago, collected for the Trustees of the Indian Museum. *J. Linn. Soc.* (*Zool.*) *22* (136), 1-64, 3 pl.

————, 1895.—Bericht űber die von Herrn Schiffscapitän Storm zu Atjeh, an den westlichen Kűsten von Malakka, Borneo und Celebes sowie in der Java-See gesammelten Decapoden und Stomatopoden. *Zool. Jb. Syst. 8,* 485-609.

————, 1896.—Veber neue und wenig bekannte Brachyuren des Hamburger und Pariser Museums. *Mitt. Mus. Hamburg 13,* 73-118, 3 pl.

Miers, E. J., 1884.—Crustacea. Report on the Zoological Collection made in the Indo-Pacific Ocean during the Voyage of H.M.S. 'Alert', 1881-1882. London. 178-322, 513-575, pl. 18-34, 46-52.

Milne Edwards, A., 1873a.—Faune carcinologique de la Nouvelle Calédonie 2. *Nouv. Arch. Mus. Hist. nat. Paris, 9,* 155-332, pl. 4-18.

————, 1873b.—Description de quelques crustacés nouveaux du Muséum Godeffroy. *J. Mus. Godeffroy 1* (4), 253-264, pl. 102.

Milne Edwards, H., 1852.—Observations sur les affinités zoologiques et la classification naturelle des crustacés. *Ann. Sci. Nat. sér.* 3, *Zool. 18,* 109-166, pl. 3 and 4.

Rathbun, Mary J., 1926.—Brachyuran Crabs from Australia and New Guinea. *Rec. Aust. Mus. 15* (2), 177-182, pl. 14-16.

Sakai, T., 1939.—Studies on the Crabs of Japan IV. Brachygnatha. Brachyrhyncha. 365-741. pl. 42-111. Yokendo Ltd: Tokyo.

Snelling, Barbara, 1959.—Distribution of Intertidal crabs in the Brisbane River. *Aust. J. Mar. Freshw. Res. 10,* 67-81, pl. 1-3.

Stephenson, T. A., Stephenson, A., Tandy, G. and Spender, M., 1931.—The Structure and Ecology of Low Isles and other Reefs. *Sci. Rep. Gt. Barrier Reef Exped. 3* (2), 17-112, pl. 1-27.

Stimpson, W., 1858.—Prodromus descriptionis animalium evertebratorum quae in Expeditione ad Oceanum Pacificum Septentrionalem a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Pars V. Crustacea Ocypodidae. *Proc. Acad. nat. Sci. Philad. 10,* 31-40 and 93-110.

Tesch, J. J., 1915.—The Catometopous genus *Macrophthalmus* as represented in the Leiden Museum. *Zool. Meded. 1* (3-4), 149-204, pl. 5-9.

————, 1918.— The Decapoda Brachyura of the Siboga Expedition. 1. Hymenosomidae, Retroplumidae, Ocypodidae, Grapsidae and Gecarcinidae. *Siboga Exped. 39* C, 1-148, pl. 1-6.

Ward, M., 1933.—New genera and species of marine Decapoda Brachyura. From the coasts of New South Wales and Queensland. *Aust. Zool. 7* (5): 377-394, pl. 21-23.

EXPLANATION OF PLATE XXIV

Fig. 1. Dorsal surface of male *Australoplax tridentata* (A. Milne Edwards, 1873) from Rockhampton, Queensland.

Fig. 2. Abdomen of male *Australoplax tridentata* (A. Milne Edwards, 1873) from Rockhampton, Queensland.

Fig. 3. Dorsal surface of holotype male *Macrophthalmus leptophthalmus* (H. Milne Edwards, 1852).

Fig. 4. Ventral surface of holotype male *Macrophthalmus leptophthalmus* (H. Milne Edwards, 1852).

Figs. 1 and 2 by Photography Department, University of Queensland, of specimen with the Australian Museum Registered Number of P 15158. (Scale lines 1 mm. apart).

Figs. 3 and 4 by courtesy of the Muséum National D'Histoire Naturelle, Paris. (Specimen has dimensions of 19.5 mm. carapace length and 24.0 mm. carapace breadth).

NOTES ON THE BEHAVIOUR IN CAPTIVITY OF A PAIR OF BANDED CORAL SHRIMPS, **STENOPUS HISPIDUS** (Olivier)

By J. C. Yaldwyn
Australian Museum, Sydney

(Based on the observations of F. G. Myers)
(Plates XXV-XXVII)

In August, 1962, Mr. C. J. Lawler observed what appeared to be a single specimen of the Banded Coral Shrimp, *Stenopus hispidus* (Olivier), while skin-diving in Congwong Bay, near the mouth of Botany Bay, Sydney. The waving of long, white antennae from a rock crevice surrounded by the large brown seaweed *Ecklonia,* at a depth of about 18 feet, attracted Mr. Lawler's attention to a shrimp with a striking colour pattern of red bands on a white body. After keeping the shrimp under at least bi-weekly observation in the same crevice for eight months, Mr. Lawler brought it in to the Australian Museum alive in April, 1963. As suspected from the underwater description, this was a fine record of *Stenopus hispidus,* long known as a prominent and abundant coral reef animal throughout the tropical waters of the Indo-Pacific and western Atlantic regions, but rarely recorded as far south as Sydney.

After bringing the shrimp to the surface in a hand-net and examining it in a glass container of sea-water, Mr. Lawler found that there was a small male riding on the back of what proved to be a much larger female. The pair were photographed extensively by Howard Hughes at the Australian Museum, but these disturbances did not break up the association. The shrimps were then placed in the aquarium of the Honourable Mr. Justice F. G. Myers, where they were under daily observation until the death of the male three months later, in June, 1963. During this period the pair separated and fed on small brittle-stars and aquarium scraps. They moulted (the male three times and the female twice) and at various times exhibited a wide range of behaviour, from mutual hostility, through a distinct courting "dance", to the characteristic "saddle" riding as illustrated in a preliminary note on this association (Yaldwyn, 1964).

This paper presents a summarised account of all aspects of behaviour recorded during the three months the pair were under observation in one or other of the F.G.M. aquaria. This is preceeded by an outline of our knowledge of the relationships, systematic position and fish-cleaning habits of the stenopodid shrimps. A later paper will deal with the distribution of *Stenopus hispidus* in the Australasian region, especially noting the numerous recent records from the Sydney area and a first record from New Zealand, and will give, as well, extended notes on the colour and colour pattern of this species.

The detailed day to day diary observations and the correlated series of Kodachrome photographs on which this paper is based were entirely the work of F. G. Myers, while the interpretation and "break-down" given here is mainly the work of the author, who takes full responsibility for the conclusions drawn from the original observations.

Systematic Position and Australian Records of the Stenopodidea

Within the Decapoda Natantia, or swimimng decapods, the stenopodid shrimps are a small group standing a little apart from the more familiar and abundant caridean shrimps and penaeid prawns. These small to medium-sized natants differ from the true caridean, or non-penaeid, shrimps and prawns in having the pleura of the 1st abdominal segment overlapping the leading edge of those of the 2nd segment and in having three pairs of chelate legs rather than two. In both these features they agree with the penaeid prawns, though they differ from the latter in having the 3rd chelipeds characteristically enlarged and in lacking the distinctive penaeid sexual organ, or petasma, on the 1st

pleopods of the male. Unlike the penaeids, however, they do not shed their eggs directly into the sea but retain them attached to the pleopods as do the caridean shrimps. They are classified then by most authors as the section, previously tribe, Stenopodidea, of equal standing with the Caridea and Penaeidea.

The classification of the section Stenopodidea has been critically reviewed by Holthuis (1946, 1955). He recognised seven genera with a total of about 23 species. Only two species have been recorded from Australia, *S. hispidus* and *Microprosthema validum* Stimpson. The Australian status and known distribution of both species, the latter under the name *"Stenopus robustus"*, have been given by McNeill & Ward (1930). They record both from north eastern and eastern Australian waters south to the Port Jackson area, New South Wales. Both are found widely in the Indo-Pacific region; *S. hispidus* ranging from the Red Sea and eastern Africa to southern Japan, Hawaii, the Tuamotu Islands, Lord Howe Island in the Tasman Sea and northern New Zealand (new record, to be published in a later paper), and *M. validum* from the Red Sea through Indonesia to southern Japan.

"Fish-cleaning" in the Genus Stenopus

Recently it has been shown by overseas workers (Limbaugh, Pederson & Chace, 1961) that the Banded Coral Shrimp, and its congeneric relative from the western Atlantic, *Stenopus scutellatus* Rankin, both have the habit of cleaning fish, a form of behaviour known for a few tropical shrimps and some tropical fish. Pairs of *S. hispidus* have been observed in coral crevices and caves with their antennae projecting and displayed in the sunlight. Fish are attracted to such obvious features as the waving white antennae (6 rami to each animal, see figs. in this paper) and remain still while the shrimp picks with its smaller claws (1st and 2nd chelae) at parasites, injured tissue and fungal growths on their bodies and fins. The coral crevices in which *Stenopus* spp. may be found apparently become known to fish as they congregate around them in numbers and some are cleaned.

As far as the present author is aware no observations have as yet been published on fish-cleaning by *S. hispidus* in Australian waters, though the species is well known and easily observed along the Great Barrier Reef and at Lord Howe Island. A report of presumed fish-cleaning by this species in the Sydney area, to be quoted in a later paper, is thus of double interest. It will be the first from the Australian area and will extend the records of this habit to the southern recorded limit of the species in warm temperate, rather than tropical, waters.

Limbaugh *et al.* (1961) recorded, from underwater observations, that juvenile *S. hispidus* appear to pair and grow up together, and that pairs attempt to stay together when disturbed. Adults, as well as juveniles, were never observed to move more than a few feet unless disturbed by an investigator. Undisturbed pairs remained in the same restricted location for many months, possibly for years. The observations published here, however, give full details of the first record of a pair of grossly unequal size, the first record of a courting or nuptial "dance" and details of the "saddle" riding already mentioned in the preliminary report (Yaldwyn, 1964).

The Congwong Bay Pair in Captivity

On the day after capture (8-iv-1963) the female of the Congwong Bay pair would have had a carapace length of 12 mm. and the large cheliped (3rd leg) 59.5 mm. long (measured from the cast shell of the 1st female moult on 18-iv-1963).

The *colour in life* of the female to the naked eye was noted on 8-iv-1963 as follows: body and appendages transluscent white with broad transverse bands of dark red on carapace, abdomen and enlarged 3rd cheliped; prominent patch of blue and some red ventrally on cephalothorax extending from basal segment of 3rd maxilliped to that of 4th leg. Transverse band of red present on anterior quarter of carapace, extending over rostrum, eye-stalks and on to ventral

surface, but not extending on to antennular or antennal peduncles. A less regularly margined band of red present on 3rd abdominal segment, extending a little on to 2nd segment. Another band of red on 6th abdominal segment extending on to proximal third of tail fan. Tail fan otherwise with some orange on either side of telson. 1st and 2nd chelae almost colourless, large cheliped transluscent white with four distinct bands of red. One present on distal third of palm extending a little on to proximal portion of both free and fixed fingers. Another present on a little more than proximal third of pálm; another band on carpus (wrist) occupying centre third and some of proximal third. Fourth band on merus occupying centre third and some of distal third. 4th and 5th legs with some red on meri.

The bands of red on carapace, abdomen and 3rd legs described above, contained not only red pigment but some dark pigment in addition, possibly blue. The gut appeared greenish through the carapace.

The male on 8-iv-1963 would have had a carapace length of about 5 mm. and the large cheliped 26 mm. long (measured from the damaged cast shell of the 1st male moult on 12-iv-1963). The colour in life to the naked eye was as described for the female. The distinctive, but apparently typical, *Stenopus hispidus* colour pattern of this pair is recorded in black and white on the photographs reproduced in the preliminary 1964 note and here on plates XXV to XXVII.

The two F.G.M. aquaria (termed tanks A and B below), in which these observations were made, were similar glass-sided tanks measuring approximately 21" long x 10" wide x 14" deep. During the period of the *Stenopus* observations, each contained about 12" of sea water and three fist-sized stones on a sand bottom. The water was not changed, though an airpump provided both bottom filtration by suction down into the sand, and water circulation within the sand itself. The stones provided had a natural growth of small brown seaweed *Pocockiella variegata* (see Dakin, 1960: 109, pl. 16 fig. 1), with its associated fauna of small ophiuroids, amphipods and other cryptic animals. The tanks were placed out of direct sunlight, under cover but not in deep shade.

Summary of Activity Observed during Captivity

1963

April 7th	(day 1)	*Stenopus* removed from Congwong Bay crevice and recognised as a pair with small male mounted on back of large female.
8th	(2)	Mounted pair placed in Myers's tank A.
12th	(6)	Male apparently deliberately separated from female and cast shell (1st male moult); male later attempted to remount female but was deliberately repulsed several times; male placed in tank B.
18th	(12)	Female cast shell (1st female moult) during afternoon.
19th	(13)	Female placed in tank B with male; "nuptial dance" observed; male mounted female again.
20th	(14)	Male accidentally dislodged from female, but remounted again within minutes. Later male separated from female and the latter deliberately stalked and repeatedly attacked male; male placed back in tank A.
28th	(22)	Male cast shell (2nd m. moult).
May 14th	(38)	Male and female both cast shells during the night (3rd m. moult; 2nd f. moult).
18th	(42)	Male placed in tank B with female; female deliberately and repeatedly attacked male; male placed back in tank A.
22nd	(46)	Male placed in tank B with female; "advance and retreat" behaviour observed.
24th	(48)	Male attempted to mount female, latter showed no hostility but thwarted each attempt.

	29th	(53)	Male mounted female for short while, later separated.
	31st	(55)	Male repeatedly attempted to remount female, latter thwarted each attempt without hostility.
June	2nd	(57)	Male living with female in same crevice of tank B.
	13th	(68)	Male mounted female for short while, later separated.
	14th	(69)	Male seen to remount receptive female (date of subsequent separation not recorded).
	19th	(74)	Male not observed outside "crevice" after this date.
	24th	(79)	Male dead.
	26th	(81)	Female killed.

Detailed Account of Selected Aspects of Behaviour

In the details given below I quote extensively and with freedom, but without direct indication other than italics, from the F. G. Myers day by day observational diary, using the day number in captivity (*day 1* = 7th April; *day 81* = 26th June, 1963) of the observation, rather than the actual date.

1. Activity, "Self-cleaning" or Toilet, and Home "Station."

One of the first things noticed about these animals in captivity was their habit of staying in the one place for long periods during the day and then moving about actively, though slowly, at night.

By *day 4* very little activity had been observed and the mounted pair had hardly moved from the original position adopted when placed in the tank. *She does not seem to move at all unless I disturb her. She must have very keen sight because she will withdraw or move away at movements a foot away, not directed at her, e.g. picking up something outside the tank. Otherwise she stands with her body arched downward and constantly appears to pick up fragments with her small 1st and 2nd chelae and put them in her mouth. Occasionally she bends down an antenna and draws it through a 1st chela, which she then stuffs into her mouth as if she had scraped something off the antenna and was eating it.* This period of adjustment lasted to *day 6*, by that time *Stenopus* appeared to be getting accustomed to extraneous disturbances. *She does not retreat, but turns or rears a little to observe movements outside the tank. She remains on a smooth, flat stone in the aquarium and did not leave it even when I put my hand into the tank and moved the stone about six inches.*

That same day the male left the female and moulted, but on attempting to remount later, was repulsed as described in the "Aggressive Behaviour" section below, and finally had to be moved for safety to another tank. When alone the female *went over her whole head and body with her small 1st and 2nd chelae, picking at it and transferring whatever she found to her mouth.* She greedily ate chopped periwinkle (*Austrocochlea* sp.) on *day 6*, but by *day 8* had settled down again to virtual daytime immobility on her selected, flat-stone home "station" (as seen in pl. XXVI fig. 1). *The female remained in the same spot all day; in order to test whether she moved some chopped periwinkle was placed on the stone about six inches from her at 9 a.m. If it remained uneaten she could not have moved, as she could only move in that direction. At 6 p.m. the female was still in same position and the food was untouched. At 7 p.m. she was standing over the periwinkle with her chelae brushing it from time to time but she still ignored it. She was still standing over the untouched periwinkle at 11 p.m.*

The male was already actively hunting and eating very small ophiuroids at night by *day 7* as described below under "Feeding." But by day he was inactive and on *day 8 remained all day in the shelter between two weed-covered stones. By 7 p.m. he was out foraging and I saw him eating a small brittle-star. There were several in his tank, but now I cannot find any. He is a real hunter and, if the female has similar habits, they do not need to depend on cleaning fish for a living. The female's inactivity and the deliberation and slowness of her movements is in marked contrast to the male, who is noticeably more active.*

Neither captive *Stenopus* swam at any time while under observation and it appears that *S. hispidus* may be incapable of deliberate swimming. *Even when startled, or pushed with a rod, they simply retreat on their legs.* On *day 10* after remaining inactive all day *the female became restless about 5 p.m. She wandered backwards and forwards in the tank and finally made a vigorous attempt to climb the glass from a standing position. She then moved to another place and after a while tried to climb the glass again. She put all her chelae against it and standing upright clawed and scratched at it for some time. After a further brief attempt to climb the glass, she sank down on the bottom resting on one front chela, which was lying flat, and remained in this position for perhaps three or four minutes. She then climbed onto a stone, appeared to feed for a while and finally took up her old position on the smooth stone. At 8.45 p.m. the female appeared to be perfectly normal and was slowly wandering over the tank. She made one perfunctory effort to climb the glass, but gave up almost as soon as she started. The male* (in the other tank) *is on his nightly prowl.* By 10.30 p.m. the female had taken up a new "station" on a weed-covered stone and the male had tucked himself under a little cave made by the overhang of a stone. *He backs himself in until only his antennae are visible.* Next day (*day 11*) the shrimps were still in their same positions and did not appear to have moved when examined at 8 a.m. and later at 5.45 p.m.

Between 7 and 9 p.m. that same day *the female was wandering slowly about and appeared to pick up little scraps and eat them. I noticed a tiny animal, no bigger than a pin's head, come out from the weed and settle on one of her antennae. It was certainly alive and moved a little way along it. She swung the antenna round, ran it through one of her small chelae, which no doubt seized the animal as she then put the chela in her mouth and moved her mouth parts.* This typical activity can be termed "self-cleaning" or toilet and was often observed. It could be a short affair as described above or a much more complete work-over with the small chelae as follows: *she picks at every part of her body, all down her legs, along all her antennae, her head, back, sides and underneath her body, curling her tail under so that she can reach there. She even picks on her eyes and around them. I have seen her spend 15 to 20 minutes cleaning herself.*

A final observation on attempted swimming records that on *day 19* the female *constantly tried to climb the glass walls scrabbling with her chelae and legs and beating her swimmerets at a great rate, but the best she could ever do was to get momentarily about an inch off the bottom and then fall back again. I feel quite sure she cannot swim.*

The evening "walks" during which feeding took place *were slow and deliberate affairs though the male was always more active than the female.* Before starting a perambulation as late as 8 or 9 p.m. *the female would remain in the same place, in her "resting position" not moving except for an occasional shifting of her legs. Her resting position is what I call her attitude when neither moving nor feeding, legs spread fairly wide and her sternum* (*the lowest part of her body arch*) *just clear of the ground* (see pl. 1). *When feeding, they seem to do a small circuit within the tank until they reach the home area and then stay there for quite a long time before starting off again.* On *day 27* the female's evening walk of 8 inches was timed as 55 minutes, on *day 28* a circular walk over the stones of about 7 to 8 inches took 45 minutes. *I don't suppose one should complain about their near inactivity because it probably makes it much easier to keep them in a small tank, but they can be boring to watch on a cold night.*

2. Feeding

For the first few days of captivity the feeding of the two *Stenopus* appeared to be restricted to the random chelar picking of fragments and the self-cleaning described in the above section. By *day 7*, however, after moulting the male was demonstrating a very deliberate hunting and feeding technique with small amphiurid ophiuroids (possibly an immediate source of calcium carbonate).

I have spent the evening watching the male Stenopus. He has been wandering round the floor of the tank and appears to be finding food in the gravel. At all events he constantly feels here and there with his small chelae and then pokes them into his mouth. At one stage he picked up a young brittle-star, at least ½ inch across. I thought it might injure him, but before I could do anything it dropped down, leaving one arm in his chela, which he ate. A little later he found another brittle-star, a little smaller and, using all four small chelae, he dismembered it with remarkable speed and ate it. It is no exaggeration to say that in a minute only two arms were to be seen. A series of photographs were taken of this ophiuroid-eating sequence. In pl. XXVI fig. 2 the male's left 1st and 2nd chelae (right on the photograph) are seen holding the disc of the brittle-star, while the right 2nd chela (on viewer's left) is breaking off one arm. The right 1st chela is carrying an arm fragment to the mouth parts and is thus out of focus. Note the left large (3rd) chela is missing after the 1st male moult.

When feeding the male walks sideways as much as forward. When he finds a fruitful place, he allows himself to sink down while his chelae explore and then stands up again to eat. It looks like a rhythmical lowering and raising of the body, until one observes him through a lens and sees the reason for it. Again on *day 9* the deliberate eating of ophiuroids was observed once more. *The male is out on his usual evening foraging expedition. When I first saw him he was holding the body of a brittle-star, having presumably eaten the arms. He took a couple of bites out of the body, just like a boy eating an apple, and then stuffed the remainder into his mouth. He wanders continually over the floor at night.*

The female would take ophiuroids too, as on *day 13,* when, after her first moult the day before, she was placed in tank B and *almost immediately found a little brittle-star, which she ate whole, spitting out the body, or test, when she had finished.* Although she would feed to a certain extent on chopped periwinkle, fragments of mussel and scraps of fish introduced into the tank, she seemed to find these more or less by chance, and her principal food appeared to be organic fragments or small animals found by random searching of the gravel or weed-encrusted stones. *During the last hour the female has been walking slowly round her tank, apparently picking up and eating scraps all the time. Twice she passed near a piece of fish, took two scraps from it and passed on. She seems to feed at random, poking all the time with her four small chelae and eating anything they chance to grasp. I do not think she looks for food at all. Her eyes and her chelae seems to work quite idependently. I have several times attracted her attention by putting a rod in front of and above her and moving it. She throws up her antennae and head and obviously watches it. At the same time her chelae continue to search among the gravel or weed and convey food to her mouth. When she reaches a piece of fish, a chela will tear a scrap off, if it happens to touch, but, unless a chela lands on the fish again, it is passed by. It does not seem that sight or smell play any part in this searching, she appears to rely entirely on touch to obtain food.*

The female *Stenopus* was quite capable of active gross feeding as shown on *day 20* when, on touching a piece of fish with a chela *while walking in the evening, she snatched it up to her mouth and chewed it for 40 minutes. It was a large piece, about a third as big as her body and she ate at least half of it. A little later she came across another small piece and ate that as well.*

Fish pieces, stray small animals and random organic fragments remained the food for both male and female during the balance of their captivity. The choice at any one time appeared to depend on chance, availability, state of moult-cycle and degree of sexual association. The smaller male was always more active than the female and showed more dexterity in searching for edible matter. *He then hung upside down on a stone and appeared to be eating scraps from the seaweed. Later he moved to the other side of the stone and hung there constantly searching with his 1st and 2nd chelae. They both explore the weed on these stones very thoroughly and seem to get a lot to eat from it.*

3. Moulting, Growth and Regeneration

The male moulted three times during the period of observation, on *day 6, day 22* and *day 38*. There were thus 16 days between both 1st and 2nd moults, and 2nd and 3rd moults. This spacing appears to be abnormal as no further moults were observed for the 41 days till the death of the male on *day 79*. (At 16-day intervals two more might have been expected, even at 32-day intervals one would have been due by *day 68*).

The female moulted twice during captivity, on *day 12* and *day 38* (note that both male and female moulted on that day). This single intermoult spacing of 26 days may also be abnormal as another moult might well have been expected before *day 81*. The death on that day was not natural; there was no evidence that the female was unwell or otherwise affected in such a way that her natural moult-cycle was interrupted. Possibly moulting is suspended during winter months, in the latitude of Sydney at least.

The male remained mounted on the female from the first day of captivity to *day 6*, then apparently left during the afternoon, moulted and later tried to remount the female. The latter deliberately and aggressively repulsed him several times (for details see below in "Aggressive Behaviour" section). As he was a great deal smaller than the female (see pl. XXVII fig. 2, and Yaldwyn, 1964, photos) and considered to be in danger in a confined space, he was moved to another tank for safety.

During the afternoon (of day 12) the female sloughed her skin. She left a complete skin on the floor of the tank, split transversely at the back a little behind the thorax. A left antennal ramus missing, presumably due to damage, at the time of capture (see pl. XXV; pl. XXVI fig. 1; and Yaldwyn, 1964, photos) was partly regenerated at this moult.

At the male second moult in captivity on *day 22* a new large left cheliped replaced the one lost almost immediately after the first moult on *day 6* (pl. XXVI fig. 2 shows the male with this 3rd chelate leg missing). It did not reach full size, however, during this growth stadium, but after the third male moult on *day 38*, regeneration was virtually complete and the limb was almost equivalent in size and colour to the right member of the pair.

In a similar manner the female lost both left and right chelipeds at her first moult in captivity. Both limbs failed to come out from the cast shell. No splitting of the external covering of the cheliped takes place during the moult, the entire hand is merely withdrawn from within the old shell. In this case both chelipeds broke away completely at the ischiobasal articulation and remained only half withdrawn from the cast shell. On *day 35*, three days before the female second moult, an appendage appeared at the site of the missing left limb and projected forward *about an inch, being perhaps a little thicker than a walking leg.* Two days later (the day before the 2nd moult) this appendage had enlarged and now had *two red bands on it, the end being turned out and bifurcated. The upper parts, or "thighs", of her four walking legs (4th and 5th legs) have become quite pink. After her first moult, the bases of her legs lost their bright blue colour and have been more a magenta. However, they are now becoming blue again.* During the next day (*day 38*) it was noted that *her colours do not seem so bright and clear—i.e. the red and white—and the whole area of her thorax has a bluish tinge. She is as active as ever, as far as she can be called active. Perhaps she is getting ready to moult.* That night the female (and the male) moulted; next day it was seen that she had regenerated a fairly long left cheliped, about half the size of the original and that *the blue at the bases of her legs was quite brilliant once again.* By *day 40* the regenerating left cheliped, now clearly seen to be deformed, had been lost and no further regeneration of this limb, or any regeneration of the right cheliped, was observed during the remainder of captivity.

4. Association and "Saddle" Riding

The male remained mounted in the "saddle" formed by the female's back for a total of about 11 days of the 81 days of observation. The unequally-sized

Table showing Moult Changes in Captive *Stenopus* during April - June, 1963.

Growth stadium	Carapace length (mm)	Large cheliped hand length (mm)	Large cheliped total length (mm)	Remarks
MALE stage a (1st m. moult, *day 6*)	approx. 5	8	26	Shell of carapace crumpled at 1st m. moult, thus measurement only approximate.
Male stage a + 1 (2nd m. moult, *day 22*)	5	8	26	Left large cheliped lost at 1st m. moult.
Male stage a + 2 (3rd m. moult, *day 38*)	5	9	28.5	Left large cheliped partly regenerated, length 18 mm.
Male stage a + 3	6	10	30.5	Left large cheliped almost fully regenerated, length 27.5 mm.
FEMALE stage b (1st f. moult, *day 12*)	12	21.5	59.5	Left antennal ramus missing.
Female stage b + 1 (2nd f. moult, *day 38*)	—	—	—	Both left and right large chelipeds lost at 1st f. moult. Left antennal ramus partly regenerated. Shell of carapace lost after 2nd f. moult, thus no measurements available.
Female stage b + 2	12	—	—	Left large cheliped partly regenerated, but deformed and later lost (length 35 mm). Left antennal ramus fully regenerated.

pair were associated in this manner when they were brought up from the Congwong Bay crevice on the 7th April, and remained thus together for the next six days despite photography, travel and transfer to an aquarium. The male then moulted and was prevented from remounting by the female. After enforced separation, a female moult, and a courting "dance", the male mounted again for parts of *days 13* and *14*. This period was terminated by vigorous hostility from the female.

After further enforced separation, they were put together again and the male attempted to mount on *day 48*, succeeded on *day 53*, later separated and attempted to remount on *day 55*, succeeding finally for periods of *days 68* to *70*. No further association of this type was observed after that date.

The first two periods of "saddle" riding, and the period when the pair were together after the synchronous moult of *day 38*, were all followed by intense and aggressive hostility directed at the male by the female (for description see section 6 below). This was quite distinct from the non-aggressive tactics used by the female to prevent the male from remounting during *days 48* to *55* (described below in the present section). Two of the three female aggressive displays followed shortly after male moults (1st and 3rd male moults; female did not have access to male between his 2nd and 3rd moults), and it appears that this behaviour of the female might be related to the newly moulted condition of the male.

Just the opposite reaction, however, was shown by the male to the newly moulted condition of the female on *day 13*. When put together after the 1st female moult of the afternoon before, the complex and distinctive courting "dance", described in the next section, took place and this led directly to the male mounting on to the back of the female again and remaining in the "saddle" riding position till next day. The male/female moult and riding relationship can be followed in sequence from the "Summary of Activity" table given above at the beginning of the behaviour section.

The riding position adopted is shown clearly from above in two photographs Yaldwyn, 1964, cover and p. 286) and from the side in one (pl. XXVII fig. 2). Though there was some variation in the angle which the male adopted astride the female, he basically positioned himself in the "saddle"-like shape formed by the dorsal surface of the female in her "resting position" (see pl. XXV and pl. XXVI fig. 1). Except when at an unusual angle (e.g. 1964, cover), the male rode with his 4th pair of legs straddling the posterodorsal part of the female's carapace, even sometimes resting on the basal portion of the latter's 3rd or 4th legs (e.g. 1964: 286), and with his 5th pair of legs braced against the proximal segments of the female's abdomen (1964: 286; and pl. XXVII fig. 2 here). The large chelipeds of the male extended outwards and forwards to about the level of the eyes of the female, while the 1st and 2nd chelae continually picked at, and transferred scraps to the mouth from, the female's dorsal carapace spines and the general area of the anterior part of the female's cephalothorax including the eyestalks. In this position the antennular and antennal flagellae of both animals (a total of 12 rami if none were missing) interlaced to a certain extent to produce the explosive effect shown in pl. XXVII fig. 2. The male himself, when mounted, adopted his normal resting position, similar to that of the female, with his body arched downwards at the junction of the cephalothorax and abdomen.

The sequence of events from *day 46* to *day 70*, covering reunion after separation, attempted mounting by male, non-aggressive action by female to prevent mounting and finally successful mounting, illustrates association or courting behaviour in marked contrast to the courting "dance" and aggressive hostility of *days 13* and *14* described in the next two sections. On *day 46* the male was placed in the female's tank at about 6.30 p.m. after an absence of 4 days. *It is now 10.30 p.m., there has been a constant pattern of behaviour. The female advances a step or two and the male retreats. They then stay quite still for varying periods, 5 to 15 minutes. The male advances a step or two and the female retreats. They then fall motionless again. There is no sign of*

aggression. By the next day they had settled down at opposite ends of the tank, but on the following day (*day 48*) they started their evening activity at about 5.30 p.m. and soon *met, stopped and looked at each other. The male then walked up to the female and tried to climb on to her legs and thence, no doubt, to her back. She showed no hostility at all, but just moved sideways or backwards sufficiently to thwart him. At 6 p.m. he gave up attempting to remount his restive horse.*

At about 9 a.m. on *day 53*, the male was mounted on the female, but was *off again by 1 p.m. Since day 48 they have been living together in friendliness with no sign of hostility on the female's part.* On *day 55* the male was attempting to remount for about half an hour, but without success. *The female did not appear to resent his efforts, but he would get one large cheliped caught under one of her legs, free it and then find she had moved just a little, try again and get his cheliped caught again and so on. He then approached her from the front, but that was no use, then from the side and she stood on her front legs with her body held almost vertical, then he went round and faced her and apparently kept trying to climb over her head. She eventually seized him, but he shook himself free and stood and looked at her for about 15 minutes.*

Within a few days of the above observation the male was spending the inactive period during daylight with the female in her "home" shelter partly under a projecting stone. *They appeared to be quite accustomed to each other* and there was no observed change in their activity pattern till *day 68.* On that day the male was seen mounted for a short while but later the pair separated. On *day 69* the only successful "saddle"-mounting to be observed during the whole period of observations took place. *The male approached the female from the side. He put his large chelipeds on her and almost stroked her. She turned her back to him and sank down and he climbed on to her back. She then stood up, walked a step or two and started to feed in an idle sort of way. After 15 minutes she was still standing and picking up scraps in a desultory way and the male simply stood in the "saddle" of her back and did nothing* (e.g. as seen in pl. XXVII fig. 2).

At no time during the pairing or "saddle" riding was anything observed that could be interpreted as copulation or attempted fertilization. The female produced no eggs during the whole period of captivity and gave no observable sign of developing eggs within the cephalothorax. (Eggs, as carried externally on *Stenopus* females, are bright blue and should be visible through the carapace internally in the ovary, at least in late stages of development). That this association was sexual in nature is, I consider, obvious, but its full significance in this pair is not clear to me.

5. Courting or Nuptial "Dance"

The day after the first female moult (*day 13*) the female was moved to the tank containing the male (separated for safety on *day 6*) and, after finding and eating a small orphiuroid as described above, she came face to face with the diminutive male. *She swept him with the tips of her antennae and then they stood for a moment with their antennae touching and quite still. They rubbed their antennae against each other for a little while and then the male moved slowly sidewards. The female constantly turned so that she always faced him. Then he ran a few steps towards her and she quickly retreated. All the time they kept their antennae touching. The male climbed a stone, so that he looked down on her (pl. XXVII fig. 1), she retreated quickly. The male lost interest and began to feed. After a moment or two, the female moved towards him and brushed him with the tips of her antennae and the slow "dance" continued—two steps to the right, with antennae touching, two to the left, with antennae still touching, the male takes two steps forward, the female two steps back. Suddenly the male made a short rush and they were no more than an inch apart, antennae laced together, large chelipeds waving and at last it appeared that the female would remain still, but she made two quick flips back till they*

were separated by the length of the tank. They then seemed to have lost interest in each other; the above sequence was timed at about forty minutes.

Later that same evening *the female found the male again and brushed him with the tips of her antennae and their "dance" commenced once more. For thirty minutes they moved sideways, forwards and backwards, ending with a short rush by the male, then the same pause with interlaced antennae and waving chelipeds followed by the final flips backwards on the part of the female bringing the sequence to an end.* They were still feeding at 10.30 p.m. and showing no interest in each other. However, next morning at 6.30 a.m. the male was mounted in the "saddle" of the female's back as discussed in the above section.

As far as I am aware such a complex courting "dance", involving both members of the pair, has not been recorded before in decapod Crustacea (*fide* Schöne, 1961). However the "dance" of the caridean shrimp *Hymenocera elegans* as shown by Dr. R. L. A. Catala of Noumea in the 16 mm. colour film, "Carnival under the Sea", can be compared here (see also Catala, 1964: 89; 1966: front cover). Both members of the bisexual pair are shown involved in a distinct, co-ordinated and complex dance, but this has not as yet been described in any detail.

6. Aggressive Behaviour

As mentioned in several of the above sections, on the day when the male dismounted from the female and moulted (*day 6,* 1st male moult), the female demonstrated quite a different pattern of behaviour. At about 5.30 p.m. *the female appeared to be restless and moved off in the direction of the male. When she approached him she opened wide the chelae of her large chelipeds and the male darted back. She then turned away and for a little while he remained where he was. He then followed her at a respectful distance and twice, when her side was turned to him he moved towards her back. On each occasion she swept him away with an antenna, no doubt accidentally. After a time she came face to face with the male and she stopped about 3 to 4 inches away. He then approached her directly and she stretched out one large cheliped with a wide opened nipper and advanced on the male. She struck at a rod held in the tank (an attempt to protect the male) so quickly and savagely that it startled the observer (F.G.M.) with its contrast to her previous slow and deliberate movements.* The female was then pushed away and the male removed to another tank.

On the day after that on which the courting "dance" observations were made (*day 14*), the male was accidentally dislodged from the female's back. He remounted again, but at about 7.30 p.m. the pair were observed separated and facing one another. *After a minute or two, the female began a slow, menacing advance, her large chelipeds extended. The male held his ground and suddenly she pounced. There was a flurry of legs and antennae and she had him firmly. It was so quick that the observer scarcely had time to separate them with a rod he had ready. The male flipped backwards to a corner partly under a stone and remained there without moving for two or three minutes. He then climbed slowly to the top of the weed, where the female saw him and again made her slow, threatening advance.* After the observer separated them again, *they both wandered about feeding, until the female saw him once more. This time she rushed straight at him and was pushed away by the rod for a third time. They settled down to feed for a short while but as soon as the female came within sight of the male, she started to stalk him. The male was finally moved to the other tank for safety.*

No attempt was made to reunite the pair till *day 42* (3 days after the synchronous 3rd male, and 2nd female, moults). Then, after 27 days separation, *the male was put in the female's tank. After about 15 minutes they met and she immediately attacked him. As often as the observer separated them she rushed at him. The only thing to do was to put him back in his own tank again.*

Summary and Conclusions

With the help of the F. G. Myers diary, the above notes have followed 81 days of captivity of a pair of *Stenopus hispidus* taken from a rock crevice at Botany Bay, Sydney. These two unequally-sized animals were associated at the time of capture, though it is not known if they were a mated pair, and the large female at least had been under observation for eight months before capture. Nothing approaching mating was observed during captivity, but complex behaviour such as back-riding, nuptial dancing and aggressive hostility were displayed by these two animals. The sequence of this behaviour appeared to be linked to their respective moult cycles. Several moults took place during captivity, but it is not considered that the stadia recorded here are of normal lengths.

Both animals were seen feeding extensively during captivity and continued with an established individual activity sequence till the male ceased to move about on the 74th day. He died five days later for no obvious reason and the female, before being killed and preserved for study on the 81st day, was still as active and as normal as at capture. Whether the paired, "saddle" riding is general, or merely an idiosyncrasy of this unusually matched pair, is not known. It does not appear to have been recorded before and its significance is still not understood. With one exception paired dancing, as distinct from unisexual display, also does not appear to have been recorded before in shrimps, crabs or other decapods. Though termed here courting or nuptial, this dancing may have a mutual recognition, rather than a sexual, significance.

It is obvious that *Stenopus*, with its propensity for fish-cleaning, its complex behaviour and its stable pair bond, is an important subject for future detailed observation and investigation. Thus the Banded Coral Shrimp, so widely used as a symbol of marine tropical pattern and diversity, should soon feature just as widely in decapod ecological and behavioural literature. Its wide distribution in both the Atlantic and Indo-Pacific, its abundance in shallow reef localities and its stability in captivity, all indicate how readily it lends itself to such investigations.

Acknowledgements

I wish to thank the Honourable Mr. Justice F. G. Myers for the detailed observations and photographs without which these notes could never have been written. I hope he feels that the long hours spent watching the slow but dramatic, behaviour and relationship of this extra-ordinary pair of animals have at last contributed significantly to our knowledge of the stenopodid shrimps. I only wish that many more of his fine photogaphs of these two animals could have been published here. I wish to thank Mr. C. J. Lawler for his initial observations on this pair and for the care with which he brought these mounted animals to the surface then to the Australian Museum; Mr. A. Healy for the excellent black and white negatives he prepared from the original Kodachrome photographs; Mr. R. Johnstone for his underwater observations on *Stenopus* in the Sydney area; Miss Caroline Gow and Barbara Yaldwyn for preparing a typed extract of the *Stenopus* observations from the original day to day aquarium diary, and finally Dr. D. J. G. Griffin and Professor L. R. Richardson for reading and commenting on this manuscript.

Literature Cited

CATALA, R. L. A., 1964.—*Carnival under the Sea*. R. Sicard, Paris. English Edit., 141 pp., 27 pls.

———— 1966.—The Aquarium of Noumea. *Aust. Nat. Hist.* 15 (5):142-146, cover photo and 3 figs.

DAKIN, W. J., 1960. *Australian Seashores*. Angus and Robertson, Sydney. Revised Edit., 372 pp., 99 pls.

GILLETT, K. & McNEILL, F., 1962 (Revised Edition). *The Great Barrier Reef and Adjacent Isles*. Coral Press, Sydney. 209 pp., 168 pls.

HOLTHUIS, L. B., 1946. The Decapoda Macrura of the Snellius Expedition I. The Stenopodidae, Nephropsidae, Scyllaridae and Palinuridae. *Temminckia* VII: 1-178, 11 pls.

———— 1955. The Recent Genera of the Caridean and Stenopodidean Shrimps (Class Crustacea, Order Decapoda, Supersection Natantia) with Keys for their Determination. *Zool. Verhand.* 26: 1-157, 105 figs.

LIMBAUGH, C., PEDERSON, H. & CHACE, F. A., 1961. Shrimps that Clean Fishes. *Bull. Mar. Sci. Gulf Caribbean* 11 (2): 237-257, 9 figs.

McNEILL, F. A. & WARD, M., Carcinological Notes. No. 1. *Rec. Aust. Mus.* XVII (9): 357-383, pls. LIX-LXI.

SCHÖNE, H., 1961. Complex Behaviour. *In* WATERMAN, T. H. (Edit.) *The Physiology of Crustacea.* Academic Press, New York. II: 465-520, 22 figs.

YALDWYN, J. C., 1964. Pair Association in the Banded Coral Shrimp. *Aust. Nat. Hist.* XIV (9): 286, cover photo and 2 figs.

EXPLANATION OF PLATES XXV-XXVII

Plate XXV. Female Banded Coral Shrimp, *Stenopus hispidus* (Olivier), in the typical "resting position" on a weed-covered, flat stone. (Carapace length 12 mm).

Plate XXVI. Fig. 1. Female *S. hispidus* showing the dorsal "saddle" formed by the angle between the carapace and abdomen in the "resting position."

Fig. 2. Male *S. hispidus* (carapace length about 5 mm) eating a small amphiurid ophiuroid. The left 1st and 2nd chelae (right in fig.) hold the disc of the brittle-star, while the right 2nd chela breaks off one arm.

Plate XXVII. Fig. 1. Male *S. hispidus* on right and female on left with antennae touching and about to begin courting "dance." Note that both female large chelipeds are missing after 1st female moult.

Fig. 2. Male *S. hispidus* "saddle" riding on female. Note the 10 (theoretically 12) interlaced antennular and antennal rami.

(All photos are of the Congwong Bay pair and were taken in colour by F. G. Myers in his marine aquaria. Black and white negatives were prepared by A. Healy).

BOOK REVIEW

"Laboratory Techniques in Zoology" by R. Mahoney.

Butterworths, London. i-vi, 404 pp., illustr., 1966. Price $9.60.

This book is intended for use as a text for those engaged in instruction in laboratory techniques in Zoology. It consists of a preface, eleven chapters and an index. The first chapter, which occupies more than one third of the text, deals with the animal kingdom phylum by phylum; these are briefly characterised. In the larger phyla lower categories are characterised. Culture, killing and preservation methods are given for the species most commonly used in laboratory demonstration. Where special structures require special treatment, e.g. staining to show protozoan flagellae, suitable methods are indicated. Embedding and sectioning techniques are outlined where necessary under the category headings. The first four pages of the first chapter are devoted to explaining "classification." It is felt that this subject is dealt with too briefly to be of real value to anyone not already conversant with the principles involved. The first chapter, as a whole, however, forms a very useful reference summary of methods in common use. The second chapter, on aquarium and vivarium management deals with an all-too-frequently neglected aspect of laboratory technology. The subsequent chapters deal with histological techniques (including embedding, sectioning and staining) and care and maintenance of microtomes. The usual general stains are dealt with and indications are given of some techniques for special purposes. Embryological techniques, fluid preservation procedures and injection and corrosion techniques are also dealt with. The organisation of a museum for teaching purposes is described and a chapter on skeleton preparation (including transparency techniques) is included. Some physiological techniques are briefly handled in a short special chapter. A useful chapter on palaeontological techniques is included and the final chapter is devoted to the presentation of useful data such as conversion factors, atomic weights and composition of buffer solutions.

This book should serve the purpose for which it was designed and written. It provides those responsible for training zoology technicians with a framework on which to base a practical course of instruction and provides a reference work in which most of the commonly used standard techniques can be looked up. It should be available to all zoology laboratory technicians.

The layout of the book and the adequately comprehensive index make it an easy work of reference.

The print is clear, illustrations are adequate although not numerous (this is not a criticism as the subject does not require profuse illustration). The paper and binding are of good quality.

C. N. SMITHERS

A NEW SPECIES OF **MISSULENA** (CTENIZIDAE - ARANEAE)

by

Vera Levitt-Gregg

(Figures 1-4)

This paper describes a new species of spider of the genus *Missulena* Walckenaer, 1805 (*Ctenizidae - Araneae*).

When right or left hand is mentioned it should be borne in mind that the spider was examined facing away from the Observer, and the position calculated when looking down on the dorsal surface.

MISSULENA PRUINOSA, sp. nov.

DESCRIPTION—

Holotype: ♂.

Cephalothorax broadly ovate, black, shining, devoid of hairs, finely granular, rear margin slightly incised; 6.3 mm. wide x 5.5 mm. long. Thoracic fovea strongly procurved, deep, with a shallow groove running from the fovea to the posterior margin. Radial grooves wanting. Pars cephalica high, rising steeply from pars thoracica.

Ocular area 4.0 mm. wide x 1.0 mm. long. Anterior median eye on raised tubercle, each eye 0.4 mm. dia., half their diameter apart. Anterior lateral eye elliptical, raised, their longest diameter 0.5 mm., separated from anterior median eye by 1.5 mm. Posterior lateral eye slightly raised, elliptical, longest diameter 0.3 mm. Posterior median eye rounded, but truncated posteriorly, greatest diameter 0.2 mm., separated from each other by 2.1 mm. (Fig. 2). Anterior row of eyes slightly recurved, posterior row strongly recurved. Anterior margin of posterior median eye almost level with posterior margin of anterior median eye.

Chelicerae black, granulated, shining, devoid of hairs on dorsal surface except on apex, robust, curving downwards, with 3 small teeth followed by 5 large and 3 small on inner margin of furrow on ventral surface, and 9 very small teeth followed by 2 large on outer margin, counted from the base towards the apex (Fig. 1). Rastellum consisting of 10 large spines, concolorous with chelicerae. Fang curved and shining, 2.5 mm. long.

Labium much longer than broad, 1.0 mm. wide x 1.8 mm. long, oval, dark brown, devoid of spines but sparsely covered with brown hairs.

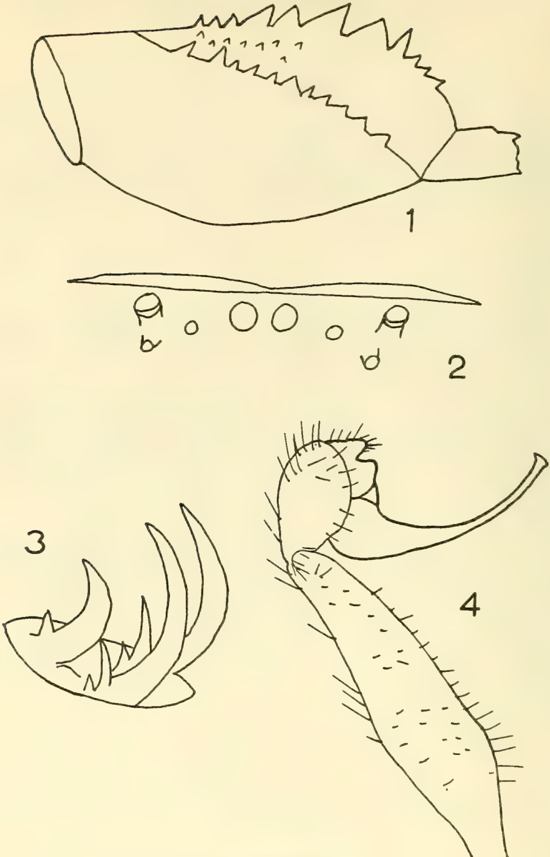
Maxillae almost square, with large lobe at anterior angle, dark brown, with scopula of reddish hairs on anterior margin.

Sternum 3.5 mm. long x 3.6 mm. wide, dark brown. Posterior sigillae deep, but ill-defined; remaining pairs of sigillae indistinct.

Legs relative lengths 4: 1: 2: 3, dark brown, with a scopula of light brown hairs on ventral surface of both metatarsi and tarsi of legs 3 and 4; 3 claws on each tarsus, one or two pectinations on superior claws, the number varying even on the same leg on the opposite side; inferior claw with one pectination (Fig. 3).

Spines a distinct pad of spines resembling an accessory rastellum on anterior side of patella 1, a smaller pad of spines on patella 2. Whole of dorsal surface of patella 3 covered with spines; only one or two spines on patella 4. All tibiae, metatarsi and tarsi with long spines. No spines on femurs.

Palpi dark brown, the tibiae having long hairs but no spines. Genital bulb light brown, with style rounded, tapering and darker towards apex (Fig. 4).



MISSULENA PRUINOSA, sp. nov.

Fig. 1. Chelicera showing dentition.
Fig. 2. Eye arrangement.
Fig. 3. Tarsal claws, 2nd leg on right hand side.
Fig. 4. Palp, palpal bulb and style.

Abdomen 7.0 mm. long, obovate, overhanging base of cephalothorax, whitish on the dorsal surface, sparsely covered with extremely short, dark brown spine-like hairs on the anterior side, becoming longer towards posterior. Ventral surface grey with whitish mottling, covered with long brown hairs; sides concolorous with ventral surface.

Spinnerets superior spinnerets short, first segment longest, last shortest and conical. Inferior spinnerets narrow, cylindrical.

MATERIAL EXAMINED—

Three specimens of this spider have been seen by me, but only one is available for description. It was captured at Angurugu Mission, Groote Eylandt in the Gulf of Carpentaria on the 23rd November, 1965, by Miss D. C. Levitt.

The Holotype is lodged in the Australian Museum, Sydney, registered no. K. 68,593.

DISCUSSION—

The specimen described above differs from all described species of *Missulena* in colouring and in the pectinations on the tarsal claws, and from all except *Missulena bradleyi* Rainbow in the hairs on the abdomen. It differs from all except *Missulena occatoria* Walckenaer and *M. bradleyi* in the spining of the legs. Although it is closest to the latter spider, it is distinguished by the dentition of the chelicerae, and the spines forming the rastellum of *M. pruinosa* are shorter than those of *M. bradleyi*.

ACKNOWLEDGEMENT—

I wish to thank my husband, M. H. Gregg, for the drawings accompanying this paper.

A NOTE ON **ORGYIA ANARTOIDES** (WALK.) (LEPIDOPTERA : LYMANTRIIDAE)

by C. N. Smithers*

This note presents data on the life history of *Orgyia anartoides* (Walk.), the Painted Apple moth or Vapourer moth. Although this species is common and well known, little seems to have been published on its life history apart from brief descriptions of the stages. The data presented were obtained from specimens in Sydney, reared at room temperature and fed on geranium leaves. Groups of larvae were reared in muslin-covered jars and individual larvae were reared in similarly-covered glass vials, the size of vial depending on the size of the larva. The moth is illustrated in *Insect Pest Leaflet* no. 112, Dept. Agriculture, New South Wales.

The egg stage lasted from eight to thirteen days, most eggs hatching in nine or ten days (see Table 1).

The number of larval instars varied from four to six. In males a few larvae underwent only four instars but most had five. In females there were five or six instars, more having six than five (see Table II). Causes of this variation were not investigated.

The larvae of *O. anartoides* are well known and a full description will not be given here. There are two recognisable forms of fifth instar one of which (female larvae) is similar to the fourth instar, the other (male larvae) being similar to the sixth instar (female) larvae. In the fourth instar, each of the large dorsal tufts of setae on the first four abdominal segments is thicker and more strongly developed than that of the following segment. This condition is also found in fifth instar female larvae. In fifth instar male larvae these tufts are very strong and similar to each other on each of the first four abdominal segments. This condition is also found in sixth instar female larvae. The final larval instar, of whatever stadium or sex it may be, has the dorsal tufts equally well and strongly developed. (This applies also to those male larvae which undergo only four instars). Using this character in combination with a measurement of the width of the head capsule, as seen directly from above, it is possible to recognise the fourth, fifth and sixth instars and to determine the sex of the fifth and sixth, the latter always being female.

Key to late instar larvae

1.	Dorsal hair tufts equally well and strongly developed on abdominal segments 1-4	2.
	Dorsal hair tufts progressively smaller on abdominal segments 1-4	3.
2.	Head capsule width 1.4 - 1.6 mm.	final 4th instar ♂
	Head capsule width 2.1 - 2.6 mm.	final 5th instar ♂
	Head capsule width 3.2 - 3.6 mm.	final 6th instar ♀
3.	Head capsule width 1.4 - 1.6 mm.	4th instar (♂ or ♀)
	Head capsule width 3.2 - 3.6 mm.	5th instar ♀

The first instar lasted five or six days, the second, third and fourth instars were a little shorter and the fifth and sixth instars about seven or eight days (see Tables III and IV).

Larvae of *O. anartoides* have been recorded from a wide variety of plants such as wattle, apple, apricot, cherry, geranium, rose and gladiolus. They also feed on cotoneaster. The indigenous host plants are probably species of wattle (*Acacia* spp.).

* Australian Museum, College Street, Sydney.

Spinning usually commenced about twenty four hours before pupation. Males had a pupal stage lasting from seven to twelve days, most taking nine or ten days; females had a shorter pupal period, mostly five or six days (see Table V). Although females spend a shorter period as pupae than males their longer larval life results in females from a given egg batch emerging later than males from the same batch.

Unmated females lived from four to thirteen days, mated individuals from six to thirteen days; unmated males lived from one to five days (see Table VI). Time of death of females seems to bear little relation to the end of oviposition.

In all groups reared males were more numerous than females the overall sex ratio being about 3 ♂ ♂ : 1 ♁ (see Table VII).

Both sexes were ready for copulation almost as soon as they emerged. Unmated females laid as many eggs as mated females, some starting to lay within twenty-four hours of emergence. The rate of oviposition was usually increased after mating. Unmated females laid from 114-746 eggs (average 380 in 9 specimens); mated females laid from 198-785 eggs (average 433 in 18 specimens). The overall egg production is not significantly different in mated and unmated females; unmated females produce infertile eggs only (see Tables VIII and IX). Oviposition took place over a period of three to six days in unmated females and three to eight days in mated females (see Table X).

Acknowledgements

I would like to thank Miss J. Walsh, Miss L. Mulligan and Mrs. K. Kota for assistance in rearing the specimens from which the above data were obtained.

TABLE I

Duration of Egg Stage

No. of Eggs	Length of stage (in days)
336	8
1,231	9
767	10
—	11
275	12
8	13

TABLE II

Number of Larval Instars

♂ ♂		♀ ♀	
No. of Larvae	No. of Instars	No. of Larvae	No. of Instars
7	4	5	5
29	5	13	6

TABLE III

Length of Larval Instars — males

Duration (in days)	Instars 1st	2nd	3rd	4th	5th
3		1	2	6	
4		24	21	18	1
5	18	4	8	6	
6	7	5	3	1	3
7	8		1	3	10
8	2	1	1		12
9		1			2
10	1				1
11				1	
12				1	

TABLE IV

Length of Larval Instars — females

Duration (in days)	Instars 1st	2nd	3rd	4th	5th	6th
3				2		
4		13	3	8		
5	6	4	10	2		
6	10	1	1		5	
7	1		3	3	5	3
8					3	3
9				2		2
10					1	1
11	1				1	1
12					1	1
13			1		1	1
14						
15				1		
16						
17						
18						
19						
20					1	

TABLE V

Length of Pupal Stage

Duration (in days)	No. of pupae ♂ ♂	♀ ♀
4		1
5		11
6		11
7	3	7
8	9	
9	28	
10	30	
11	11	
12	9	

TABLE VI

Length of Life of Adults

Duration (in days)	Mated ♀♀	Unmated ♀♀	Total ♀♀	Unmated ♂♂
1				2
2				19
3				20
4		1	1	11
5		1	1	3
6	3		3	
7	1	1	2	
8	4	1	5	
9	5	1	6	
10	1	1	2	
11	2		2	
12		2	2	
13	2	1	3	

TABLE VII

Sex ratio

	♂♂	♀♀	♂ : ♀
Individually reared December, 1965	17	10	1.7 : 1.0
Individually reared March/April, 1966	19	8	2.4 : 1.0
Group reared December/January, 1966	69	14	5.0 : 1.0
Totals:	105	32	3.3 : 1.0

TABLE VIII

Rate of Oviposition — unmated ♀♀

♀ No.	Days after emergence—No. of eggs									Days alive	Total Eggs
	1	2	3	4	5	6	7	8	9		
A	50	61	0	3						4	114
B	0	0	0	261	474	9	1	1		12	746
C	28	17	39	129	254					5	467
D	0	7	10	48	292					7	357
E	0	0	12	516	19					10	547
F	0	0	0	8	33	148	234	17	1	12	441
G	0	55	296	0	9					9	360
H	14	99	1							13	114
I	0	0	0	62	49	110	57			8	278

TABLE IX

Rate of Oviposition — Mated ♀ ♀

♀ No.	Days after emergence — No. of eggs								Days Alive	Total Eggs
	1	2	3	4	5	6	7	8		
J	0	0	0	55	90*	306	1		8	452
K	0	3	0	0*	172	150	46		9	371
L	346*	25	10	37	12				11	430
M	401*	0	5	28	7	1			13	442
N	275*	8	4	31	4	6			10	328
O	4*	175	0	0	5	11	2	1	13	198
P	0	23	22*	226	14				7	285
Q	0	0*	0	210	27	3	1		9	241
R	0	480*	21	53	8	3			9	565
S	0	22*	97	161	15				6	295
T	0	35	76*	256	7				6	374
U	4	38*	166	42	2				6	252
V	0	0*	5	210	89	9			9	313
W	0*	463	10	5	15	0	0	1	9	494
X	0*	687	22	31	31	14			11	785
Y	473*	13	45	23	10	0	4		8	568
Z	2	23*	574	9	13	8			8	629
AA	0*	667	12	48	28	12	6		8	773

* = mated

TABLE X

Oviposition period (in days)

Days	Unmated ♀ ♀	Mated ♀ ♀
3	2	1
4	4	6
5	2	4
6	1	4
7		2
8		1

A REDESCRIPTION OF **SAPROMYZA CARINATA** THOMSON, AND A NOTE ON SOME AUSTRALASIAN DIPTERA DESCRIBED BY FRANCIS WALKER (DIPTERA: LAUXANIIDAE)

by

B. R. STUCKENBERG

(Natal Museum, Pietermaritzburg, South Africa)

(Text-figures 1-4).

Thomson (1868, *Freg. Eugen. Res., Dipt.*, pp. 563, 567) described two species of Lauxaniidae from Australia, *Sapromyza carinata* Thoms. and *Lauxania melanogaster* Thoms., both on material from Sydney, N.S.W. The latter has since been recognised as a common species of the genus *Steganopsis* Meijere, but the former seems not to have been recorded subsequently and was not mentioned by Malloch in his various papers on Australian Lauxaniidae published in the *Proceedings of the Linnean Society of New South Wales* during 1925 to 1928. Hendel (1908, *Genera Insectorum 68*, p. 34) noted that *carinata* was "sicher keine *Sapromyza*-Art."

During my recent visit to the British Museum (N.H.), Mr. A. C. Pont obtained the type series of *carinata* on loan from the Naturhistoriska Riksmuseum in Stockholm in order to ascertain whether the species is a muscid as the description fits in a general way certain Australian species with a yellowish body and carinate face; *carinata* proved in fact to be a lauxaniid and belongs in the large assemblage of Australian species placed by Malloch in "*Sapromyza.*" In Malloch's (1928, *Proc. Linn. Soc. N.S.W. 53* (4), pp. 355-9) key *carinata* runs out at *mariae* Malloch and clearly is closely related to that species. Thomson's material consists of six males and two females, one of the latter labelled "Type." He described two varieties, "Var. b" having the apex of the abdomen black, "Var. c" having the abdomen black with yellow base (only the "Type" specimen), the typical form being "rufo-testacea." As no type was designated by Thomson in his description, one of the males is hereby designated lectotype and labelled accordingly; it is a specimen with largely yellowish-brown abdomen, darkish brown on the apical two segments.

The classification of the Australian "*Sapromyza*" species is very unsatisfactory. Many, if not all, have little affinity with *Sapromyza* Fallén *s. str.* and require relocation in new or other genera; some of the species indeed have the definitive characters of *Minettia* R.-D. or *Lyciella* Collin, though they should not be included in those genera. The morphology of all the species requires thorough investigation, particularly with regard to points such as the development of eversible glands in the abdomen of the female and variation in the number of segments comprising the postabdomen. There are also many species awaiting description.

It may be worth mentioning here that the following Australian species described by Francis Walker belong in "*Sapromyza*" *sensu* Malloch (1927, *Ibid. 52* (4), p. 215); the types are in the British Museum (N.H.).

Helomyza pallida Walker, 1852, *Insect. Saundersiana, 1, Dipt.* Pt. 4, p. 405.

Stated to come from "Van Dieman's Land"; the specimen marked as the type of this species is labelled "Tasmania." *Sapromyza griseodorsalis* Malloch may be a synonym.

Helomyza rufifrons Walker, 1852, *Ibid.*, pp. 404-5.

The specimen marked as the type is labelled "Tasmania" and is in poor condition.

Sciomyza lineata Walker, 1852, *Ibid.*, p. 398.
Sapromyza bicoloripes Malloch may be a synonym

Sciomyza testacea Walker, 1852, *Ibid.*, pp. 398-9.
Species near *hirtiventris* Malloch.

Sciomyza australis Walker, 1852, *Ibid.*, p. 399.
The type is in poor condition and lacks the abdomen; a yellowish-brown species with 1+3 dorsocentrals, intra-alar absent, and two strong ventral bristles on the apex of the middle tibia.

Helomyza marginalis Walker, 1857, *Trans. ent. Soc. Lond. 4*, p. 220.
A specimen which may be the type of this species is in extremely poor condition and lacks the head; it bears an almost illegible label on which only the name can be made out, and another label in Walker's hand reading "*robusta Walk.*"

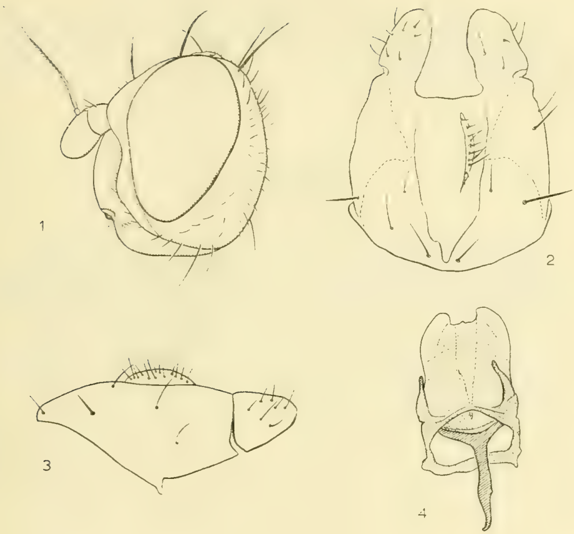
The type of *Sapromyza tincta* Walker (1852, *Insec. Saundersiana, 1, Diptera*, Part 4, p. 371) is also in the British Museum (N.H.). It appears to be a species of *Homoneura* V. d. Wulp, *Homoneura tincta* (Walker), NEW COMBINATION.

Description of *Sapromyza carinata* Thomson.

Diagnostic characters: A generally yellowish-brown species, fore legs largely dark brown, middle and hind legs with dark brown markings; face narrow with prominent longitudinal carina; 0+3 dorsocentrals, anterior pair well behind suture; intra-alar bristle present; middle tibia with two strong dorsal preapical bristles and four terminal bristles two of which are especially long and strong; mesopleural bristle long and slender; ♂ genitalia as in figs. 2-4.

♂ ♀. Head in lateral view shown in fig. 1. Frons a little longer than broad, slightly convergent anteriorly, some brownish-grey dusting around anterior margin of ocellar triangle; orbital stripes shining, brownish, converging a little and departing from eye margin; interfrontal area matt, mostly blackish-brown, anterior part of frons narrowly yellowish-brown. Face narrow, much higher than broad, deeply emarginate below, epistomal margin at midpoint being above level of lower end of eye, face carinate over entire length, profile as in fig. 1, shining yellowish-brown with some infuscation at middle part of epistome. Parafacials greyish-white pruinose. An almost linear depression extends from antennal socket obliquely downwards onto and across parafacial, passing close to eye margin, that part of parafacial thus affected closely following carinate structure of face in contrast to remainder around eye. Antennae very short, yellowish-brown, third segment broadly rounded; arista sub-basal, with very short hairs. Occiput infuscated. Thorax yellowish-brown. Fore legs mostly dark brownish, femur narrowly yellowed basally. Middle and hind femora yellowish with narrow apical infuscation; mid-tibia brownish-yellow with brownish apical quarter; basitarsus dull yellowish with apical infuscation, remaining tarsomeres brownish. Abdomen rather variably coloured, in some specimens extensively but irregularly yellowish-brown with some fulvous areas, in others largely dark brown, one female with shining blackish abdomen obscurely yellowish on sides at base. Wing unpatterned, yellowish tinge in costal and subcostal cells; costa as in *Sapromyza;* r-m crossvein near middle of discal cell, just beyond level of apex of first vein; costal index about 2.8; fourth vein index about 1.3 (apical/preapical).

Frontal bristles rather small, reclinate, anterior pair before apex of orbital stripes; ocellar bristles diverging outwards and slightly forwards, of moderate size; gena with some short bristles and bristly hairs; 0+3 dorsocentral bristles, anterior pair almost midway between scutellum and suture and much shorter than second pair; a strong intra-alar bristle present; only prescutellar acrostichal bristles present; mesopleural bristle long, slender, mesopleural hairs rather weak (unlike *mariae*); two sternopleural bristles; propleural strong; fore



Figs. 1-4. *Sapromyza carinata* Thomson. (1), Head of ♂ (2, 3). Hypopygium in dorsal and lateral views, one of the cerci omitted from fig. 2. (4). Aedeagus in dorsal view.

femur fringed with short, fine hairs along most of antero-ventral surface but no proper preapical comb present; fore tibia with fairly strong preapical; mid-femur with row of strong, short bristles on apical half of anterior face; mid-tibia with two preapical bristles, a slightly shorter dorsal one and a longer somewhat antero-dorsal one, also two strong ventral bristles at apex and two much weaker ones, one antero-ventral, the other postero-ventral. Hind tibia with short preapical.

Wing length, measured from extreme base, 4.3-4.7 mm.

Acknowledgements

Thanks are due to Mr. Per Inge Persson for the loan of the material of *carinata* and to Mr. A. C. Pont who referred it to me. Identifications of the Walker types mentioned above were made originally by Mr. J. C. Deeming and subsequently confirmed by me.

EDITORIAL NOTE . . .

For some of the period during which this part and the next of the Australian Zoologist were being set up by the printers, the Hon. Editor was absent from Australia on a trip to Japan and south-east Asia. He wishes to acknowledge, with grateful thanks, the help rendered by Dr. J. C. Yaldwyn and Mr. C. Smithers, with proof-reading and correspondence during his absence.

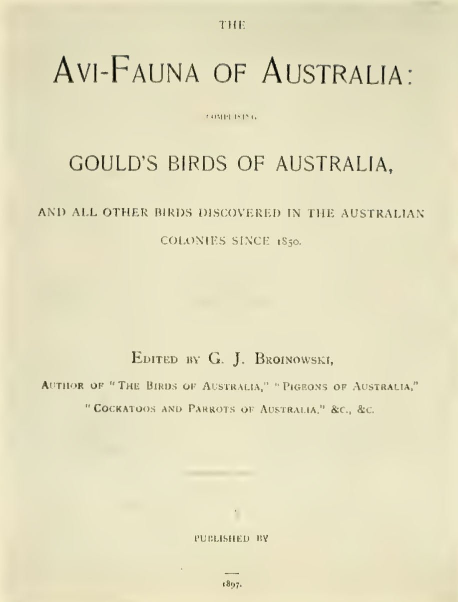
Mr. K. Hindwood kindly donated to the Society some of the blocks illustrating his paper on Broinowski.

Authors alone are responsible for the opinions expressed in their contributions.

Portrait: Thomas James Lempriere

(For explanation, see page 355)

—From the original in the Mitchell Library, Sydney.



THE

AVI-FAUNA OF AUSTRALIA:

COMPRISING

GOULD'S BIRDS OF AUSTRALIA,

AND ALL OTHER BIRDS DISCOVERED IN THE AUSTRALIAN COLONIES SINCE 1850.

EDITED BY G. J. BROINOWSKI,

AUTHOR OF "THE BIRDS OF AUSTRALIA," "PIGEONS OF AUSTRALIA," "COCKATOOS AND PARROTS OF AUSTRALIA," &C., &C.

PUBLISHED BY

1897.

Title page of the *Avi-Fauna of Australia*, 1897 prospectus.

Plate from the *Avi-Fauna of Australia*, 1897 prospectus, figuring the Yellow-tailed Pardalote.


GOULD'S
BIRDS OF AUSTRALIA

A FACSIMILE REPRODUCTION IN A REDUCED FORM

REPRODUCED BY

G. J. BROINOWSKI

PUBLISHED IN [illegible] PARTS

Title-page of the prospectus of *Gould's Birds of Australia*, 1910.

Cover of the prospectus of *Gould's Birds of Australia*, 1910.

Gracius Joseph Broinowski, 1837-1913.
(From *The Emu*, 41, 1942, plate 29)

THE AVI-FAUNA OF AUSTRALIA.

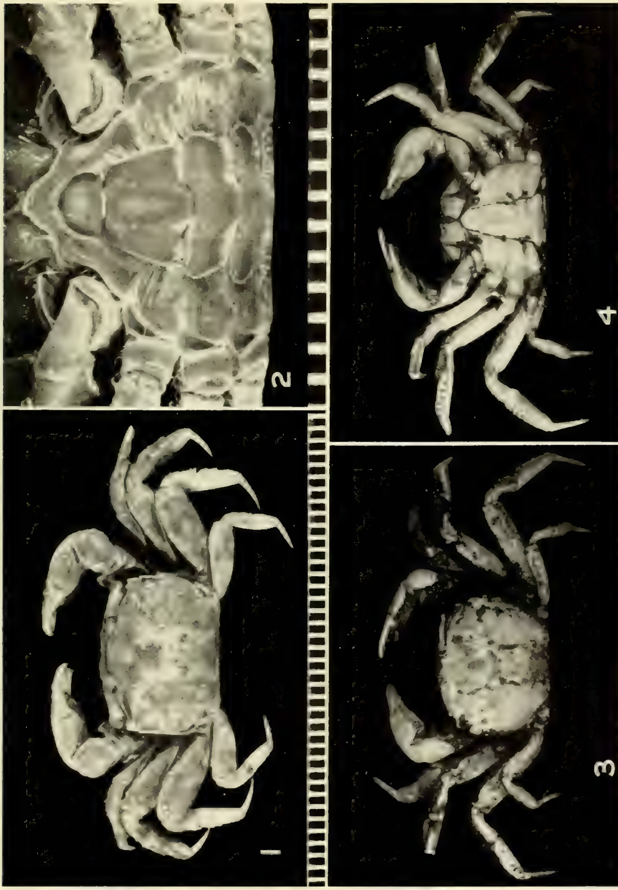
ILLUSTRATED IN COLOURS AND POPULARLY

DESCRIBED

BY

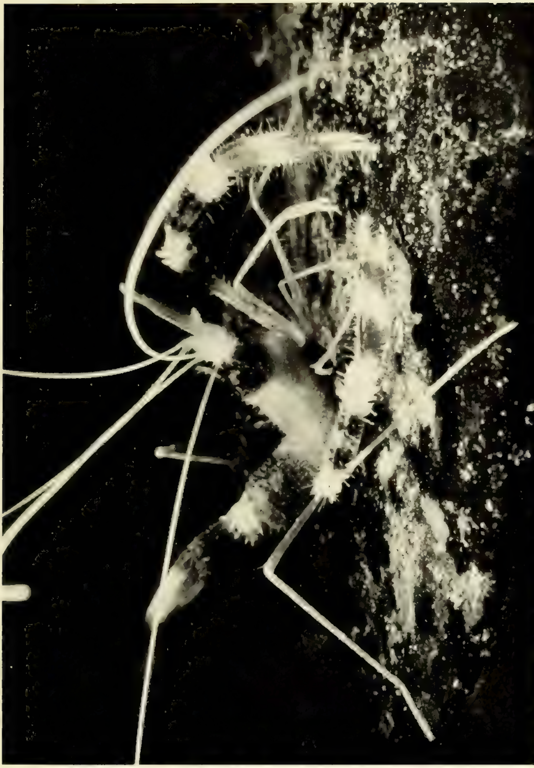
G. J. BROINOWSKI,

Title page of the Avi-Fauna of Australia, 1910.



Australoplax and *Macrophthalmus*

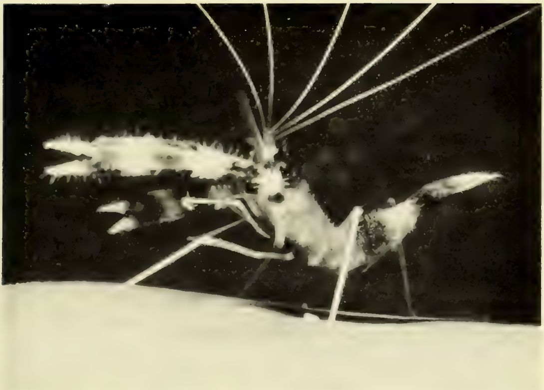
(For explanation, see page 376).



Banded Coral Shrimp

Photo: Hon. F. G. Myers.

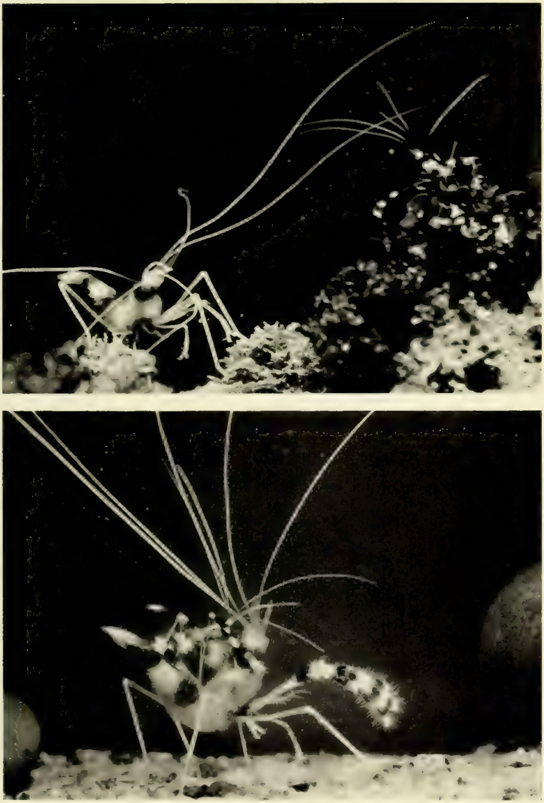
(For explanation see page 389)



Banded Coral Shrimps

(For explanation see page 389)

— *Photos: Hon. F. G. Myers.*



Banded Coral Shrimps

(For explanation see page 389).

— *Photos: Hon. F. G. Myers.*

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

MEMBERSHIP

(The Society's year commences on 1st July)

Fees are as follows:—

Class	*Amount of Subscription*
Associate Member	\$ 2.10 per annum
Ordinary Member	\$ 4.20 „ „
(Members joining after 1st January in any year pay one-half subscription).	
Life Associate Member	\$21.00 in one sum
Life Member	\$42.00 „ „ „
Honorary Member	Elected for services to Australian Zoology or to the Society
Honorary Associate Member	
Junior Members (aged 16 or under)	50 cents per annum

TITLES

(Conferred by the Council)

Fellow		For valuable services to the Society or to Australian Zoology
Associate Benefactor	For contribution of \$200.00	to the Society's Funds
Benefactor	„ „ \$1,000.00	„ „ „ „
Endowment Member	„ „ \$2,000.00	„ „ „ „

PRIVILEGES:

Members of all classes may attend all meetings of the Society and its various Sections. Every member (other than an Associate, Life Associate or Junior Member) receives a free pass to Taronga Zoological Park and Aquarium, and twelve tickets each year, admitting 12 adults or 24 children to the Park only.

APPLICATION FOR MEMBERSHIP

should be addressed to the Honorary Secretary, Royal Zoological Society of New South Wales, c/o Australian Museum, P.O. Box A.285, Sydney South, New South Wales.

PUBLICATIONS

The Australian Zoologist, published at irregular intervals since 1914. Thirteen volumes to date.
Proceedings, published since 1933-34.

AUSTRALIAN ZOOLOGICAL HANDBOOKS AND SPECIAL REPRINTS.

"Bibliography of Australian Entomology, 1775-1930", by A. Musgrave, 1932.
"A Check List of the Birds of Paradise and Bower Birds," by T. Iredale, 1948.
"Revision of the New South Wales Turridae," by C. F. Laseron, 1954.
"The Published Writings of Tom Iredale, with an Index of his new Scientific Names," by D. F. McMichael & G. P. Whitley, 1956.
"A Reclassification of the Order Odonata," by F. C. Fraser, 1957.
"Dragonflies of Australia," by F. C. Fraser, 1960.

Orders and enquiries should be sent to the Honorary Secretary, Royal Zoological Society of New South Wales, c/o Australian Museum, P.O. Box A.285, Sydney South, New South Wales.

CONTENTS OF THIS PART

Wholly set up and printed in Australia, for the Royal Zoological Society of New South Wales by

Surrey Beatty & Sons, Rickard Road, Chipping Norton, N.S.W. — 602-7404

INDEX TO VOLUME XIII

(1) INDEX TO SUBJECTS

(2) INDEX TO AUTHORS

DATES OF PUBLICATION

Part 1, pages 1-82, plates i-vii .... September 18, 1963
Part 2, pages 83-218, plates viii-xi .... Angust 10, 1965
Part 3, pages 219-302, plates xii-xix .... July 6, 1966
Part 4, pages 303-404, plates xx-xxvii .... December 14, 1966

★

Printed and published for the Royal Zoological Society of New South Wales, c/o Australian Museum, P.O. Box A.285, Sydney South

by

E. J. Miller & Co., Marrickville, New South Wales (Part 1)

Surrey Beatty & Sons, Rickard Road, Chipping Norton, New South Wales (Parts 2-4)